WATERSHED PLAN
and
ENVIRONMENTAL IMPACT STATEMENT

SQUAW CREEK
LOWER WOLF
WATERSHED

BROWN & DONIPHAN COUNTIES, KANSAS

NOVEMBER 1988

WATERSHED PLAN AND ENVIRONMENTAL IMPACT STATEMENT

SQUAW CREEK LOWER WOLF WATERSHED

Brown and Doniphan Counties, Kansas

Abstract:

This document describes a plan of land treatment and grade stabilization dams to reduce erosion and flood damages in the Squaw Creek Lower Wolf Watershed. Alternatives considered during planning include: no project action, a national economic development plan a resource protection plan, and a recommended plan. Economic benefits exceed costs for the recommended plan. Sponsors are responsible for 21 percent of the installation costs. Environmental impacts include: reduced upland erosion, reduced sedimentation, maintenance of the long-term productivity of soils, reduced flood damages, reduced scour, decreased terrestrial habitat, increased aquatic habitat, improved water quality, and increased wildlife habitat quality. High maintenance costs of rural, county, and state roads will be reduced. Many acres of highly productive cropland will be protected and preserved for future generations.

This document is pursuant to authorization under Public Law 566 funding and to fulfill requirements of the National Environmental Policy Act.

This Plan/EIS has been prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended (16 USC 1001-1008) and in accordance with section 102(2)(C) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 USC 4321 et seq.).

Prepared by: Wolf River Watershed Joint District No. 66
Brown County Conservation District
Doniphan County Conservation District
Kansas State Conservation Commission
Kansas Fish and Game Commission
U.S. Department of Agriculture,
Soil Conservation Service
U.S. Department of Agriculture,
Forest Service

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WATERSHED AGREEMENT

between the

Wolf River Watershed Joint District No. 66
Brown County Conservation District
Doniphan County Conservation District

(referred to herein as sponsors)

State of Kansas

and the

Soil Conservation Service
United States Department of Agriculture

(referred to herein as SCS)

Whereas, application has heretofore been made to the Secretary of Agriculture by the sponsors for assistance in preparing a plan for works of improvement for the Squaw Creek Lower Wolf Watershed, State of Kansas, under the authority of the Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1008); and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to SCS; and

Whereas, there has been developed through the cooperative efforts of the sponsors and SCS a plan for works of improvement for the Squaw Creek Lower Wolf Watershed, State of Kansas, hereinafter referred to as the watershed plan-environmental impact statement, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through SCS, and the sponsors hereby agree on this plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this watershed plan and including the following:

1. The Wolf River Watershed Joint District No. 66 will acquire, with other than Public Law 566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated cost $191,100.)

2. The Wolf River Watershed Joint District No. 66 hereby agree that they will comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. 4601 et. seq. as implemented by 7 C.F.R. Part 21) when acquiring real property interests for this federally assisted project. If the sponsor is legally unable to comply with the real property acquisition requirements of the Act, it agrees that before any federal financial assistance is furnished, it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance. In any event, the sponsor agrees that it will reimburse owners for unnecessary expenses as specified in 7 C.F.R. 21, 1006 (c) and 21.1007.

The cost of relocation payments in connection with the displacements under the Uniform Act will be shared by the sponsors and SCS as follows:

	Sponsors (percent)	SCS (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	21	79	0 a/

a/ Investigation of the watershed project area indicates that no displacements will be involved under present conditions. However, in the event that displacement becomes necessary at a later date, the cost of relocation assistance and payments will be cost shared in accordance with the percentages shown.

3. The Wolf River Watershed Joint District No. 66 will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The Wolf River Watershed Joint District No. 66 will obtain all necessary federal, state, and local permits required by law, ordinance, or regulation for installation of the works of improvement.

5. The percentages of construction costs to be paid by the Wolf River Watershed Joint District No. 66 and by SCS are as follows:

Works of Improvement	Sponsors (percent)	SCS (percent)	Estimated Construction Costs (dollars)
15 Grade Stabilization Dams	0	100.0	$1,880,500
Grade Stabilization Dam No. 7-11	7.4	92.6	$ 192,200 a/

a/ Includes $14,300 nonproject cost to accommodate roadway

6. Cost-sharing rates for the establishment of enduring land treatment practices are a varying percent of the average cost of installing the enduring practices in the selected plan for the evaluation unit. The cost-share rate to be paid by landowners or operators (Brown and Doniphan County Conservation Districts) and by SCS are as follows:

Practice	Sponsors (percent)	SCS (percent)	Estimated Construction Cost (dollars)
Terraces - 485 miles	35	65	$1,121,300
Underground Outlets - 48 miles	35	65	635,800
Diversions - 20 miles	35	65	489,500
Water and Sediment Control basins - 82	35	65	107,000
Grade Stabilization Structures - 161 a/	30	70	1,238,000
Grassed Waterways - 160 acres	35	65	112,900
Critical Area Planting - 131 acres	35	65	21,100
Pasture and Hayland Planting - 700 acres	35	65	52,700
Forestland Improvement - 2,660 acres	100	0	46,600

a/ Small, on-farm structures installed as part of the planned land treatment

The estimated total PL 83-566 financial assistance cost for enduring practices is $2,517,800.

7. The percentages of the engineering services costs to be borne by the Wolf River Watershed Joint District No. 66 and SCS are as follows:

Works of Improvement	Sponsors (percent)	SCS (percent)	Estimated Engineering Costs (dollars)
15 Grade Stabilization Dams	0	100.0	$ 617,600
Grade Stabilization Dam No. 7-11	7.4	92.6	$ 65,300 a/

a/ Includes $4,800 nonproject cost to accommodate roadway

8. The Soil Conservation Service will assist the Brown and Doniphan County Conservation Districts in providing technical assistance to landowners or operators to plan and install land treatment practices shown in the plan. Percentages of technical assistance costs to be borne by sponsors and SCS are as follows:

Works of Improvement	Sponsors (percent)	SCS (percent)	Estimated Technical Services Costs (dollars)
Land Treatment Practices	15	85	$1,502,400
Forestland Improvement	20	80	38,500

9. The Wolf River Watershed Joint District No. 66 and SCS will each bear the costs of project administration that each incurs, estimated to be $35,600 and $319,100 respectively.

10. The Brown and Doniphan County Conservation Districts will obtain agreements from owners of not less than 50 percent of the land above each grade stabilization dam. These agreements state that the owners will carry out conservation farm or ranch plans on their land and ensure that 50 percent of the land is adequately protected before construction of any dam.

11. The Brown and Doniphan County Conservation Districts will obtain applications from owners of not less than 75 percent of the land in the problem area, indicating that they will carry out the planned land treatment measures. Applications will be obtained before the first long-term land treatment contract is executed.

12. The Brown and Doniphan County Conservation Districts will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed plan.

13. The Brown and Doniphan County Conservation Districts will obtain agreement with landowners or operators to operate and maintain the land treatment practices for the protection and improvement of the watershed.

14. The Wolf River Watershed Joint District No. 66 will be responsible for the operation, maintenance, and replacement of the grade stabilization dams including mitigation by actually performing the work, or arranging for such work in accordance with agreements to be entered into before issuing invitations to bid for construction work.

15. The costs shown in this plan are preliminary estimates. Final costs, to be borne by the parties hereto, will be the actual costs incurred in the installation of works of improvement. Land treatment costs will be based on average costs for each practice installed.

16. This agreement is not a fund-obligating document. Financial and other assistance to be furnished by SCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

17. A separate agreement will be entered into between SCS and sponsors before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

18. This plan may be amended or revised only by mutual agreement of the parties hereto, except that SCS may deauthorize or terminate funding at any time it determines that the sponsor has failed to comply with the conditions of this agreement. In this case, SCS shall promptly notify the sponsor in writing of the determination and the reasons for the deauthorization of project funding, together with the effective date. Payments made to the sponsor or recoveries by SCS shall be in accord with the legal rights and liabilities of the parties when project funding has been deauthorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between SCS and the sponsor(s) having specific responsibilities for the measure involved.

19. No member of or delegate to Congress shall be admitted to any share or part of this plan, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

20. The program conducted will be in compliance with all requirements respecting nondiscrimination, as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 CFR 15), which provide that no person in the United States shall, on the ground of race, color, national origin, sex, age, handicap, or religion, be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity conducted or assisted by the Department of Agriculture.

WOLF RIVER WATERSHED
JOINT DISTRICT NO. 66

Route 1 Box 123

Everest, Ks. 66424
Address Zip Code

By Robert A. Schecher

Robert A. Schecher
Title President

Date December 6, 1988

The signing of this plan was authorized by a resolution of the governing body of the WOLF RIVER WATERSHED JOINT DISTRICT NO. 66

adopted at a meeting held on November 29, 1988

George Hageman

George Hageman, Secretary

Hiawatha, Ks. 66434
Address Zip Code

Date December 6, 1988

BROWN COUNTY CONSERVATION DISTRICT

202 North Morrill
Hiawatha, Kansas 66434
Address Zip Code

By Robert Tollefson
Robert Tollefson

Title Chairman

Date November 14, 1988

The signing of this plan was authorized by a resolution of the governing body of the BROWN COUNTY CONSERVATION DISTRICT

adopted at a meeting held on November 14, 1988

Edward Hageman Jr.
Edward Hageman, Jr., Secretary

Hiawatha, Kansas 66434
Address Zip Code

Date November 14, 1988

DONIPHAN COUNTY CONSERVATION DISTRICT

440 E. Locust
Troy, Kansas 66087
Address Zip Code

By Lawrence Meidinger
Lawrence Meidinger

Title Chairman

Date December 5, 1988

The signing of this plan was authorized by a resolution of the governing body of the DONIPHAN COUNTY CONSERVATION DISTRICT

adopted at a meeting held on December 5, 1988

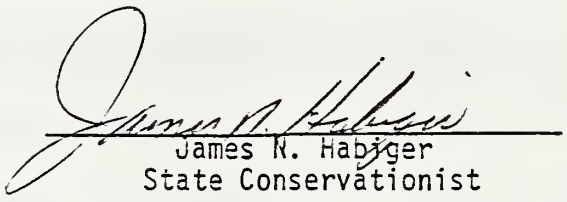
Vivian Middleton
Vivian Middleton, District Mgr.

Troy, Kansas 66087
Address Zip Code

Date December 5, 1988

Soil Conservation Service
United States Department of Agriculture

Approved by:



James N. Habiger
State Conservationist

12/12/88
Date

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SUMMARY OF WATERSHED PLAN/ENVIRONMENTAL IMPACT STATEMENT

Project Name: Squaw Creek Lower Wolf Watershed

Counties: Brown and Doniphan State: Kansas

Sponsors: Wolf River Watershed Joint District No. 66
Brown County Conservation District
Doniphan County Conservation District

Description of Recommended Plan:

The recommended plan includes 16 grade stabilization dams, land treatment structure systems at 42 gully erosion problem areas, required land treatment on 8,810 acres, and accelerated land treatment on 1,890 acres. A total of 58 severe erosion problem areas will be treated with the project. About 2,660 acres of forestland will be treated and managed for long-term timber production.

The grade stabilization dams include design storage for sediment and floodwater. The dams will generally control drainage areas of 100 acres and greater. The land treatment structure systems consist of small on-farm-size structures with drainage areas generally less than 50 acres. These systems may include one or more grade stabilization structure, diversion, water and sediment control basin, or a combination of the three.

Resource Information:

Size of Watershed (ac) 73,040

Land Ownership	Percent
Private	99.0
State	0.7
Local Public	0.3

Number of Farms - 184 Average Size - 400 (ac)

Important Farmland - 11,340 (ac) prime farmland

Wetlands - minor acres not affected by project

Endangered Species - none affected

Cultural Resources - none affected

Land Use:	Total Watershed		100-Year Flood Plain	
	Acres	Percent	Acres	Percent
Cropland	46,390	64	5,530	80
Grassland	17,570	24	370	5
Forestland	4,430	6	520	7
Other	4,650	6	550	8
Total	73,040	100	6,970	100

Problem Identification:

Problems identified within the watershed are: moderate to severe sheet and rill erosion on 21,600 acres; ephemeral gully erosion on 260 acres (voids) which depreciates the productivity on an additional 1,600 acres of associated untreated cropland; voiding of 2,160 acres due to projected gully growth; depreciated productivity on 3,680 acres associated with gullies; severe maintenance and bridge/culvert replacement costs for 102 road crossings; flood damages on 6,970 acres; flood plain land damage on 420 acres; high replacement costs for 15 flood plain and major tributary bridges; business and residential flood damage at Sparks; railroad damage; and soil moisture limitations.

Early in the planning process 115 severe erosion problem areas were identified. An estimated 97 required group action. Some problem areas were treated by landowners with private and state funds while others were too costly to treat with P.L. 566 funds. For these reasons this analysis was restricted to measure the economic significance of 83 of the 97 problem areas.

Sheet and rill erosion will cost farmers an estimated $111,700 in average annual income. Ephemeral erosion damages are estimated to be $143,200. Gully erosion damages are estimated to be $101,300. Depreciated cropland damages are estimated to be $198,900. High maintenance and bridge/culvert replacement costs are estimated to be $314,700. Road ditch sediment clean out costs are about $60,000 per year. Flood damages to crop, pasture, other agriculture, sediment, and road and bridge are estimated to be $309,700. Flood plain scour damage is estimated to be $20,600. Potential bridge replacement cost savings amount to a estimated $126,100. Business and residential flood damages at Sparks are estimated to be $2,300. Railroad damages are estimated to be $19,600. Reduced farm income from soil moisture limitations was estimated to be $168,100.

Farmers spend an estimated $89,900 each year attempting to hold back gully development in terraced fields. Bridge and culverts are undercut by advancing gullies; therefore, useful life may be only a few years instead of 25-30 years, as designed. Infrequent flooding causes large flood plain damage.

Candidate Plans Considered:

Alternatives considered include no-project action, large floodwater retarding dams, grade stabilization/floodwater retarding dams, small land treatment grade stabilization structures, water and sediment basins, and diversions in conjunction with land treatment measures above each severely eroding problem area.

Project Purposes: The project purposes include watershed protection and flood prevention.

Principal Project Measures:

16 grade stabilization dams
Land treatment structure systems at 42 problem areas
8,810 acres required land treatment
1,890 acres accelerated land treatment
2,660 acres forestland treatment

Project Costs:	PL-566 Cost		Other Funds		Total
	$	%	$	%	$
Land Treatment Measures:					
Required	1,120,300	65	602,400	35	1,722,700
Structure Systems	1,060,300	68	492,700	32	1,553,000
Accelerated	337,200	67	165,400	33	502,600
Forestry	-0-	-0-	46,600	100	46,600
Structural Measures:					
Grade Stabilization Dams	2,673,100	93	191,100	7	2,864,200
Project Administration	319,100	90	35,600	10	354,700
Technical assistance	1,307,800	85	233,100	15	1,540,900
Total	6,817,800	79	1,766,900	21	8,584,700

Project Benefits Dollars a/:	Value	Percent
Agricultural:		
Upland	$ 322,400	53.0
Flood plain	10,100	1.7
Subtotal	332,500	54.7
Urban:		
Residential	200	-
Road, Bridges, and Utilities	275,700	45.3
Total	$ 608,400	100.0

a/ Price Base 1988

Acres Benefited: Total - 19,250, Land Treatment - 10,970,
(cropland) Structural - 8,280

Impacts:

Land Use Changes - 16 Grade Stabilization Dams

Converted From (Ac.):		Converted To (Ac.):		
		Grassland [a/]	Forestland	Miscellaneous
Cropland	48	12	--	36
Grassland	148	38	--	110
Forestland	52	13	--	39
Miscellaneous land	7	3	--	4
Total	255	66	--	189

a/ Dam and spillway areas seeded to a native grass mixture and managed for wildlife.

Natural Resources Changed or Lost:

Wooded Flood Plain (ac) - none
Wetlands (ac) - loss/gain essentially equal
Cultural Resources (name) - none

Wildlife Habitat	Loss Before Compensation	Compensation	Net Change
Forestland (HU)*	330	330	0
Herbaceous (HU)	630	660	+ 30

Fisheries - Change of 8.2 miles of intermittent stream to reservoirs.
Change 2.9 miles of ephemeral stream to reservoirs.

Prime Farmland (ac) - 260 acres increase

Major Conclusions: (Final statements - interagency comments)

Areas of Controversy: (Final statements - interagency comments)

Issues to be resolved: (Final statements - interagency comments)

Table A is a comparison of alternatives considered in planning. Impacts of the alternatives on key economic, environmental, and social factors are summarized in the table.

*Habitat units equal the rated quality value (variable 1 to 10) multiplied by acres

Table A - Summary Comparison of Alternatives[a/]

Environmental, Economic, or Social Effects	(1) Going Program	(2) NED Plan	(3) Recommended Plan	(4) Resource Protection Plan
Total Project Cost	$1,331,400[c/]	$5,299,900[b/]	$8,584,700[b/]	$14,120,500[b/]
Local Share of Installation Cost (non-PL 566)	1,331,400	1,085,700	1,766,900	2,626,400
Annualized OM&R Cost[d/]	NA	61,200	96,000	152,900
Annualized Cost[d/]	NA	354,500	563,000	912,500
Annualized Benefit[d/]	NA	440,800	608,400	807,500
Flood Damage Reduction				
Reduce cropland and pasture flood damage on 6,970 acres - percent reduction	1	4	5	7
Reduce other agricultural flood damages on 22 farms - percent reduction	0	3	4	5
Reduce flood damages- percent reduction on:				
15 bridges	0	9	12	16
8 miles of road	0	9	12	16
8 miles of railroad	0	5	6	8
Reduce flood plain scour on 420 acres- percent reduction	0	1	1	2
Erosion				
Maintain conservation measures - cropland acres (1988-20,000 acres)	24,000	30,690	34,700	38,590
Stabilize gullies to benefit upland cropland acres	0	14,900	19,250	24,100
Sedimentation				
Watershed outlet sediment yield - tons (1988 - 422,500 tons)	382,100	325,400	215,300	172,200
Flood plain sediment deposition - acres (1988 - 1,140 acres)	1,250	750	460	260
Prime Farmland				
Maintain or increase acres of prime farmland - acres	11,090	11,320	11,350	11,400
Forestland				
Timber production treatment - acres	0	2,660	2,600	2,660

a/ 1988 price base
b/ Going land treatment cost are excluded
c/ Going program land treatment cost
d/ 50-year evaluation period at 8 5/8 percent with benefit and cost being annualized for 60 years

INTRODUCTION

The watershed plan and environmental impact statement have been combined into a single document describing plan formulation, expected environmental impacts, and the basis for authorizing federal assistance for implementation.

The USDA Soil Conservation Service (SCS) and Forest Service, Kansas State Conservation Commission, and Kansas Fish and Game Commission assisted the local sponsors in developing the plan. Other federal, state, and local agencies also assisted by providing information, reviewing data, and helping with assessments.

The plan was prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566 (83d Cong., 68 Stat. 666), as amended (16 USC 1001-1008), and in accordance with Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA), Public Law 91-190, as amended (42 USC 4321 et seq.). The Soil Conservation Service is responsible for compliance with the National Environmental Policy Act.

PROJECT SETTING

Squaw Creek Lower Wolf Watershed is comprised of 73,040 acres (114 square miles) in Brown (12,820 acres) and Doniphan (60,220 acres) Counties in northeastern Kansas. (See Project Map, Appendix D.) The watershed is located in the Missouri River Basin in Water Resources Council Area 10240005200.*

Population of the incorporated cities (Leona and Severance) in or bordering the watershed totals 380. Rural population is about 470. 1/** Complete population information and projections are shown in Table I, Appendix C. 2/ 21/ 30/ 31/

Economy of the area is based on agriculture. The 184 farms in the watershed average about 400 acres each. Principal crops are corn, grain sorghum, wheat, alfalfa, and soybeans. Beef production is the major livestock enterprise. Most farms are diversified.

Normal annual precipitation is about 36 inches. Approximately 85 percent of the area's floods occur between April and October during the 178-day average growing season. 16/ Ten percent of the watershed is included in the 100-year flood plain.

Land use in the watershed is 65 percent cropland, 23 percent grassland, 6 percent forestland, 4 percent other land, and 2 percent streams, ponds, and gullies.

Gentle sloping land of three percent or less occurs on about 3 percent of the watershed. The remaining watershed land is categorized into slope groups of 3-6 percent, 6-10 percent, and 10 percent plus. These make up about 28, 44, and 25 percent respectively of the soil groups.

The eroded soils within the watershed have low natural fertility and organic matter. Infiltration of water is impaired and they are more difficult to till.

The historical change in land use dramatically contributed to excessive erosion. The area was essentially grassland until the late 1800's when large increases in population, number of farms, and large number of acres farmed took place in northeast Kansas. The conversion of grassland to cropland changed the runoff characteristics. Plowing

*All information and data, except as otherwise noted by reference to source, were collected during watershed planning investigations by the Soil Conservation Service and the Forest Service, U.S. Department of Agriculture.
**Numbers appearing in the text correspond to the numbers of the references.

followed by several tillage operations left the soil largely unprotected which in turn caused severe soil erosion.

In the 1940's terracing and waterway construction was introduced. These practices were readily accepted as a tool to reduce erosion. Land use the past 10 to 15 years has been relatively stable.

PROBLEM AND OPPORTUNITY IDENTIFICATION

Major problems in the watershed are caused by erosion and flooding. Other problems are created by shortages of water-based recreational areas and of water for municipal, industrial, and agricultural use. The flood plain includes 5,600 acres of cropland that are subject to flood damages. About 60 percent of the watershed is eroding severely and is a significant source of damaging sediment. Gully erosion limits the use of 27,300 acres. The annual erosion and flood damages are estimated to be $1,497,900 as shown in Table 5.

Erosion and Sedimentation

According to the Kansas 208 Water Quality Management Plan, the watershed is in one of the more highly erodible areas of the state. Approximately 1,211,100 tons of soil are displaced through erosion annually.

Current land treatment evaluation procedures require that the analysis be based on evaluation units. By definition these units require similar practices, similar costs per acre, and respond to treatment in the same way. District Conservationists, Area Specialists, and Water Resources Planning Staff discussed various evaluation units and agreed to use slope groups as the basic unit. They selected three slope groups namely 5, 7 and 10 percent. All soils evaluated within the watershed were assigned one of these groups. Problems and solutions were shown by these categories.

Sheet and rill erosion analysis shows that about 21,600 acres (30 percent of the watershed) are presently eroding at a rate which reduces the productive capacity and quality of the soil resource (exceeding 5 tons per acre per year). Most of this area erodes at rates ranging from 7 to 25 tons per acre with an average of 18 tons per acre per year. The very steep soils may erode up to 60 tons/acre. Nearly 25 percent of the watershed is in the steep slope category.

Most sediment is being flushed through stream channels and into the Missouri River. Some intransit sediment is deposited temporarily in watershed streams. Other sediment deposition areas include farm ponds, flood plains, roads and borrow pits. Dredging, land smoothing, road grading, and loading and hauling are common costs incurred in the watershed and off project to handle the sediment deposits.

Some locations have lost over four feet of soil due to sheet and rill erosion. Natural fertility is lost. Commercial fertilizers bonded to soil particles and organic material are eroded away. Soil intake rates decrease, tillage costs increase, and crop yields are reduced. The following table shows sheet and rill erosion rates by evaluation unit.

Table B - Sheet and Rill Erosion Rates - 1988

Evaluation Unit a/	Cropland		Grassland/Forest Land		Miscellaneous		Total	
	Acres	Tons/Ac./Yr.	Acres	Tons/Ac./Yr.	Acres	Tons/Ac./Yr.	Acres	Tons/Ac./Yr.
1	11,850	10.1	5,890	1.1	920	8.8	18,660	7.2
2	18,390	12.5	9,140	1.3	1,420	11.5	28,950	8.9
3	10,630	35.4	5,280	2.9	830	22.6	16,740	24.5
Flood Plain	5,530	1.3	890	1.1	--	--	6,420	1.2

a/ Evaluation units 1, 2, and 3 are percent slope groups - categories 5, 7, and 10 percent respectively

Gross sheet and rill erosion was estimated for three land use categories. Grassland and forestland were combined since the rates are quite similar. The following table shows the 1988 sheet and rill erosion estimates and photo 1, page 13, shows an example of this type erosion. At the present erosion rates, sheet and rill erosion damages discounted to 1988 will total $111,700 on an average annual basis.

Table C - Gross Sheet and Rill Erosion - 1988

Evaluation Unit a/	Cropland		Grassland/Forest Land		Miscellaneous		Total	
	Acres	Tons/Yr.	Acres	Tons/Yr.	Acres	Tons/Yr.	Acres	Tons/Yr.
1	11,850	119,700	5,890	6,500	920	8,100	18,660	134,300
2	18,390	229,900	9,140	11,900	1,420	16,300	28,950	258,100
3	10,630	376,100	5,280	15,300	830	18,800	16,740	410,200
Flood Plain	5,530	6,900	890	1,000	--	--	6,420	7,900
Total	46,400	732,600	21,200	34,700	3,170	43,200	70,770	810,500

a/ Evaluation units 1, 2, and 3 are percent slope groups - categories 5, 7, and 10 percent respectively

Ephemeral erosion usually occurs on untreated cropland. It is caused by concentrated flow from snow melt or rainfall in natural water courses. Some farmers try to fill in these gullies before harvest while others harvest around them. Some crop is left unharvested and harvest and tillage costs are increased. This type of erosion causes an estimated $143,200 average annual damage to untreated cropland. Photo 2, page 13, shows the typical ephemeral erosion pattern. Photo 3, page 14, shows an example of the terminal end of an ephemeral drainageway as it empties into an advancing gully. Photo 4, page 14, shows an example of machine damage due to an ephemeral drain. A combine has dropped into an ephemeral drain causing severe damage to the machine and delaying harvest. The following table shows the 1988 ephemeral erosion rates by category:

Photo 1 - Typical sheet and rill erosion on untreated cropland

Photo 2 - Ephemeral gully erosion and on-site sedimentation typical of untreated cropland

Photo 3 - Gully and ephemeral erosion typical of this watershed

Photo 4 - This photo shows a combine with its front wheels in a large ephemeral gully

Table D - Ephemeral Gully Erosion - 1988

Evaluation Unit a/	Untreated Cropland Acres	Untreated Cropland Tons/Acre/Year	Void Acres	Void Tons/Year
1	6,500	4.5	70	29,300
2	10,400	4.1	120	42,600
3	5,700	8.0	70	45,600
Total	22,600	5.2	260	117,500

a/ Evaluation unit 1, 2, and 3 are percent slope groups categories 5, 7, and 10 percent respectively.

Gullies account for approximately 13 percent of the total soil loss in the watershed. Gullies cause permanent damage to agricultural land. Gully erosion affects the use of about 27,300 acres of agricultural land. Some grassed waterways have been made ineffective by advancing gullies resulting in failure of terrace systems and field crossings. About 910 acres have been permanently damaged by gullies. Photo 5, page 17, shows an example of a very large, active gully that has claimed several acres of productive cropland.

Channelizing of Wolf River in the 1920's and 1930's set in motion an erosion cycle that is well advanced. Most water courses have a series of overfalls moving upstream which will result in many more acres of gullies in the future if left unchecked. The 1988 gully acres in untreated cropland were 510, treated cropland 270, and other land 130 for a total of 910 acres. The average annual damages associated with future gully growth were projected to be $101,300.

Gullies advancing up roadside ditches threaten farmstead and field entrances and agricultural land adjacent to the roadside. Farmers have a continuing maintenance cost which reduces their net income. Photo 6, page 17, shows a typical gully beside a paved road undercutting the road and extending into the crop field.

In addition to the agricultural land concerns, eroding gullies constantly threaten the public transportation system. Special and expensive design and construction methods are needed at stream crossings to counter the effects of gullies and erosion. Photo 7, page 18, shows where typical severe channel erosion has exposed bridge pilings and bridge footings. Future bridge replacement costs will be much greater because of this erosion. Culverts are commonly installed with a drop of as much as 10 feet from one side of the road to the other. Concrete aprons and/or rocks are generally needed at the downstream ends to retard undercutting of culverts. Routinely, rock and earth fill must be hauled in to replace that which has washed away. Photo 8, page 18, shows an example of fill dirt being placed at the downstream end of a box culvert. The stream channel is about five feet below the bridge apron. The wing wall is missing and the toe wall has been undercut.

Road shoulders are often severely eroded as the result of gullies advancing up roadside ditches at bridges and culverts. Maintenance crews spend considerable time and money filling and reshaping the shoulders. The life expectancy of road crossings may be 15 years or less under these conditions whereas the culvert could last 25 years or more. The added costs to maintain the transportation system above the severely eroding problem areas was estimated to be $314,700. Sediment clean out of ditches from eroding cropland costs another $60,000.

Erosion hazard is the main factor limiting more intensive use of upland cropland. Erosion also threatens prime farmland (see page 29 for projected loss). Farm owners and operators have converted some rowcrop to alfalfa, red clover, wheat, and grass as a means of controlling erosion on land affected by the advance of gullies. Potential income from more profitable crops has been foregone. This trend is expected to continue. The conversion of cropland to grassland will cost farmers an estimated depreciated cost of $198,900 as gullies continue to advance.

Flood plain scour in the watershed accounts for approximately 1 percent of the total erosion. Scour damage occurs on about 420 acres. Scour damages are estimated to be $20,600 annually.

A tabulation of gross erosion from all categories is a dramatic expression of the watersheds total erosion problem. The following table provides a tabulation of gross erosion by land use.

Table E - Gross Erosion - 1988

Type	Land Use			
	Cropland	Grassland/Forestland	Misc.	Total
	Average Tons/Year			
Sheet and rill	732,600	34,700	43,200	810,500
Ephemeral	117,500	--	--	117,500
Gully	139,600	20,700	--	160,300
Scour	13,600	--	--	13,600
Streambanks	--	--	109,200	109,200
Total	1,003,300	55,400	152,400	1,211,100

Photo 5 - Less than 50 years ago this gully area was all cropland

Photo 6 - Typical gully erosion undercutting a blacktop road

Photo 7 -

Severe channel erosion has exposed bridge pilings and concrete footings

Photo 8 - Fill dirt is being placed around a box culvert. Note that the stream channel has eroded more than five feet below the bridge apron. Gully headcut migration has undercut the toe wall and caused one wing wall to fail.

Average annual erosion damages from those categories evaluated are listed in the following table:

Table F - Average Annual Erosion Damage - 1988

Sheet and Rill	Ephemeral	Gully	Depreciated	Scour	Road Systems	Road Ditch Sediment	Total
			Dollars				
111,700	143,200	101,300	198,900	20,600	314,700	60,000	950,400

Flooding Problems

Agricultural income is reduced by flooding on approximately 6,970 acres, including about 5,530 acres of cropland. Flood plain cropping pattern includes 3,870 acres of corn, 800 acres of soybeans, 740 acres of grain sorghum, 60 acres of wheat, 60 acres of alfalfa, 370 acres of grassland, 520 acres of forestland, and 550 acres of miscellaneous land including river channel. Frequency of overbank flow ranges from three times in 4 years to once in 11 years. Small localized flooding causes considerable damage and inconvenience to farmers in the watershed. Flood damages by reach, type, and amount are shown in Table G. The Project Map (Appendix D) shows reaches.

Table G - Average Annual Flood Damages by Reach[a/]

Reach	Acres	Urban $	Crop and Pasture $	Other Agric. $	Road $	Rail-road $	Scour $	Bridge Constr. $	Total $
1 b/	790		27,600	9,500	-	-	3,400	3,500	44,000
2 b/	1,000	-	25,300	12,200	1,000	-	1,600	19,700	59,800
3	-	-	-	-	-	-	-	-	-
4 b/	1,080	-	24,700	4,600	2,100	-	2,100	17,300	50,800
5 b/	1,040	-	12,700	200	100	100	3,800	21,500	38,400
6 b/	1,140	2,300	55,500	2,400	1,300	5,900	7,100	34,300	108,800
7	410	-	3,800	600	500	-	-	22,400	27,300
8	1,510	-	67,500	1,700	3,500	13,600	2,600	7,400	96,300
Total	6,970	2,300	217,100	31,200	8,500	19,600	20,600	126,100	425,400

a/ WRC projected 1988 current normalized prices for crop and pasture and scour; all other 1988 price base

b/ Mainstem reaches

Floods damage growing crops and forage grasses which are knocked over and/or covered with sediment, washed away, or reduced in quality. Crop yields are also reduced due to delays in planting and/or harvesting. In addition, floods that occur before or shortly after planting cause extra tillage and reseeding. Damage is not substantially affected by the duration of flooding, which is usually less than 24 hours.

Flooding of other agricultural items causes damage to buildings, fences, livestock, and feed yards on 57 farms. Many miles of fences are destroyed or damaged by floods. Most farmsteads have been located out of the flood plain because of the frequency of flooding. Installations such as machine sheds, livestock pens, feed bunks, and water tanks are frequently damaged. Considerable expense is incurred to clean up debris after each flood. Photo 10, page 21, shows example flood damage where a field of large hay bales is surrounded by floodwater.

The design, frequency of replacement, and maintenance of bridges are affected by flooding and erosion. Fifteen bridges and 8 miles of dirt, gravel, and asphalt roads are subject to flood damage. About 102 other bridges are affected by erosion. Floods wash away road surfacing, scour road shoulders, fill road ditches with mud, and damage bridges. Bridge abutments are often washed out. While bridges are under repair, traffic must be rerouted. This is inconvenient and costly. County and township budgets are not sufficient to make timely replacements and repairs after a flood, hence these facilities are commonly in poor condition.

About 8 miles of railroad track are subject to flooding. Train schedules are interrupted and railroad beds eroded during floods. Photo 9, page 21, shows an example of such damage.

The towns of Leona, Severance, and Sparks have experienced residential and commercial flood damages. With the exception of Sparks, these towns have developed mostly on lands situated above the 100-year flood plain.

Flooding indirectly affects everyone in the area due to loss of use of utilities, transportation systems, and loss of business to those serving the agricultural community.

Photo 9 - Sections of railroad tracks were washed about 20 feet off the road bed during the June 7-9, 1984, flood

Photo 10 - Large round hay bales surrounded by floodwater

Table H summarizes flood damages by major categories by frequency.

TABLE H - Flood Damages By Flood Frequency

Type	2-Year	10-Year	50-Year	100-Year
Agricultural				
Crop and Pasture				
Total Damages ($)	$ 81,200	$ 629,900	$1,049,200	$1,361,600
Area Flooded (Ac.)	(990)	(4,510)	(6,410)	(6,970)
Other (Farms, Fences, Etc.)				
Total Damages ($)	1,600	91,800	186,300	204,300
Subtotal Damages ($)	82,800	721,700	1,235,500	1,565,900
Urban				
Total Damages ($)	200	1,900	32,000	34,600
Roads, Bridges, and Utilities				
Total Damages ($)	2,000	58,600	293,800	326,400
TOTAL DAMAGES ($)	$ 85,000	$ 782,200	$1,561,300	$1,926,900

A major storm occurred June 7-9, 1984, which included this watershed (Regional Disaster declared in Kansas, FEMA 714-DR-KS). Several counties reported severe erosion and flood damages. Doniphan County estimated road and bridge damage of $4.1 million or $6,950 damage per mile. About 30 percent of Doniphan County roads are in the watershed. Based on this relationship, this storm caused an estimated $1.2 million damage to Doniphan County's roads and bridges in the watershed. Assuming that all roads and bridges within the watershed were damaged at the same rate as Doniphan County, then road and bridge damage from this storm totaled about $1.5 million. Much of this damage was to roads and bridges above the flood plain. A railroad track was damaged. Photo 9, page 21, shows railroad track condition after being washed off the road bed. The storm was an infrequent event estimated between the 100 and 500 year event. Flood damages for all categories were estimated for this flood assuming damages at the 100-year frequency. Flood damages were estimated to be $1.9 million for this storm.

Water Supply Problems

Ground water in the watershed is generally sufficient for domestic use except during periods of drought. The major source of ground water is the glacial drift over most of the watershed. Yield from alluvial deposits is low.

Water-based recreation needs are estimated at 25,000 annual recreation visits for boating and fishing in the watershed. Brown State Fishing Lake is not large enough to meet current need for water-based recreation (See Project Formulation section for more detailed discussion of recreational needs and Table II Appendix C.)

Fish and Wildlife Habitat Problems and Opportunities

The major factor influencing fish and wildlife conditions in the watershed is land use. Past land uses have decreased habitat diversity and available edge. Future changes are expected to be minor. There is an opportunity to increase diversity by interspersed plantings of grassland and woodland in large cropland areas, and maintenance of wooded riparian habitat.

There is an opportunity to improve fisheries in the Wolf River by reducing sediment and other pollutants in streams. Sediment can affect downstream fisheries diversity by temporarily filling pool segments. Fewer pools and longer runs that have resulted from sedimentation of Wolf River have lowered the diversity of fish. 35/

Research 37/ indicates that suspended sediment lessens quality and quantity of food available to fish. This reduction of food may affect survival by reduced growth and decreased resistance to disease and toxic substances.

Other Problems and Opportunities

State fire protection goals are 0.1 percent loss per year for woodlands and 0.5 percent loss per year for grasslands. The Forestry Work Plan 5/ prepared for Wolf River Watershed by the State and Extension Forester shows that more intensive fire protection is needed on about 19,500 acres to meet these goals. This will be accomplished with the going program.

The Wolf River is subject to Kansas Surface Water Quality Standards (KAR 28-16-28b through 28f) administered by the Kansas Department of Health and Environment (KDHE). Under Kansas Water Quality Standards, designated uses of Wolf River include agricultural water supply, industrial water supply, aquatic life, and non-contact and consumptive recreation.

With completion of the nonpoint source assessment, KDHE has developed more definitive water quality problem identification criteria that show water quality in the Wolf River impairs aquatic life, domestic water supply, groundwater recharge, and recreation uses. The aquatic life support use is impaired by suspended solids, turbidity, phosphorus, nitrate-nitrogen and pesticide concentrations. Nitrate nitrogen exceeds the aquatic life criterion by over three-fold. The waters are hard but the amount of total dissolved solids is not sufficient to impair uses of this water for agriculture.

Wolf River fecal coliform bacteria is very high and exceeds the recreation use criterion by six-fold. Pesticides have been detected in over half the samples collected from the Wolf River. The mean concentration of atrazine far exceeds the criteria for support of both aquatic life and drinking water supply. Alachlor also exceeds the criterion for drinking water supply. The alluvial aquifer is also threatened by pesticides in the river. Additional pesticides have been found that exceed the recommended criteria level including the priority pollutants DDT and Dieldrin (see Table VI, Appendix C, C-4).

KDHE maintains a water quality monitoring station on the Wolf River near Sparks. Appendix C, Table X, provides a summary of water quality data for this site as well as seven other reference sites. In comparing Wolf River water quality to the seven reference sites, we find that Wolf River has been degraded by agricultural nonpoint source pollutants. We also conclude that Wolf River water quality will continue to deteriorate unless corrective action is taken.

INVENTORY AND FORECASTING

Scoping of Concerns

Table I summarizes consideration of the relative impact of alternatives on environmental, economic, and social factors. This analysis was made early in planning to determine significance to decision making and to design the environmental evaluation. The scoping meetings involving this interdisciplinary/interagency team coupled with correspondence from state and federal agencies and assesment findings showed that alternatives would have no significant impact on drainage, mineral resources, stream classification, ground water, irrigation, air quality, visual resources, minority populations, or threatened or endangered species. Therefore, these factors will not be discussed in the impacts section although some basic data concerning these factors have been collected in order to determine the magnitude of impacts. Significant factors were used to scope the study, compare alternatives, and to present the impacts of the recommended plan.

Table I - Resources and Problems Significant to Decision Making

Natural Resources and Problems	Degree of Impact a/	Significance to Decision Making	Remarks
Flooding	Major	Medium	Damage to residences, businesses, and reduces agric. income
Streamflow	Moderate	Low	Impacts high flows most
Drainage	Minor	None	
Gullies	Major	High	Prevents L.T. installation
Erosion	Major	High	Reduce agric. income
Sedimentation	Major	Medium	Affects diversity of aquatic species, high road and ditch maintenance
Land use	Moderate	Medium	
Prime farmland	Moderate	Medium	Threatened by erosion
Mineral resources	Minor	None	
Water supply	Moderate	Medium	Shortage of M&I
Ground water	None	None	Insufficient for M&I
Wetlands	None	None	
Water quality (other than sediment)	Major	High	High bacterial, pesticide, and nutrient counts in storm runoff
Air quality	Minor	None	
Fish habitat	Minor	Low	Lack species diversity
Wildlife habitat	Moderate	Medium	Lacks habitat diversity
Endangered, threatened plants and animals	None	None	No critical habitat identified
Visual resources	Minor	Minor	Rural setting, little change expected
Cultural resources of national significance	Minor	Low	None affected
Minority populations	None	None	
Recreation	Minor	Low	Opportunity for 25,000 visits
Human health and safety	Moderate	Medium	
Agricultural income	Major	High	14% watershed below low income level
Relocations	None	Low	None expected
Wild fires	Minor	Low	
Road and Bridge Maintenance	Major	High	County road maintenance budgets cannot keep up with current costs

a/ Relative magnitude of impact of alternatives:
Major - significant
Moderate - readily apparent and somewhat significant
Minor - detectable but slight
None - at lower level of detention if at all

Existing Resources

In 1982 about 10 percent of Brown and Doniphan County farms had gross sales less than $2,500, and 14 percent of Brown and Doniphan County farmers worked 100 or more days off the farm. Only 20 farms in the watershed used 150 days or more of hired labor in 1982. 22/ Although many farmers have low gross farm sales and maintain off-farm jobs, most of the farms in the watershed gross over $20,000 per year. In 1980 approximately 14 percent of the watershed population was below the low income level. Per capita income 21/ for watershed counties is below state and national averages (See Table V, Appendix C, and reference 30/). Two farms are owned by minorities.

Transportation routes in Wolf River Watershed are essential to the economy. About 90 percent of the watershed is within 3 miles of all-weather roads. Kansas Highways 7, 20, and 120 and U.S. Highway 36 cross the watershed. The Missouri Pacific and the Union Pacific railroads also serve the marketing needs.

Sixteen percent of the land is classified as prime farmland. Land use is shown in Table J. Gully acreages were subtracted from cropland and grassland acres for evaluation purposes. Land ownership is: private, 72,310 acres; local public, 220 acres; and state, 510 acres.

Table J - Present Land Use

Land Use	Evaluated Flood Plain		Upland		Total	
	%	Acres	%	Acres	%	Acres
Cropland	80	5,530	63	41,740	65	47,270
Pastureland	5	370	25	16,670	23	17,040
Forestland	7	520	6	3,640	6	4,160
Other Land	2	130	4	2,700	4	2,830
Stream Channel & Ponds	6	420	1	410	1	830
Gullies	-	-	1	910	1	910
TOTAL	100	6,970	100	66,070	100	73,040

Most of the watershed consists of upland soils developed in loess or glacial till. An extensive area is classified in the Monona, Shelby, Sharpsburg, Marshall, and Morrill series. Typically, these friable, well-drained or moderately well-drained soils have a silty or loamy subsoil. The loess soils are predominantly Grundy, Monona, and Marshall series. The Grundy soils are somewhat poorly drained. The Shelby and Morrill soils are formed in glacial till and are well drained. Pawnee and Grundy soils have a clayey subsoil and occupy the upper reaches of the watershed. The valleys within the watershed are less than a mile wide. The major alluvial soils are the silty Judson

and Kennebec soils and the clayey Wabash soils. Most of the soils are used for cultivated crops and are predominantly in Land Capability Classes II, III, or IV. 40/

A coal resource (Elmo - a bed in the Scranton shale formation) estimated at 5 million tons underlies 2 percent (5 square miles) of the watershed. 7/ The high sulfur content, excessive overburden thickness, and the thin and discontinuous nature of the coal layer are primary deterrents to its development. Limited sources of sand, gravel, and limestone exist in the watershed. 9/ 10/ Sand and gravel, highly contaminated with silt and clay, are produced intermittently from a few open pits. Crushed limestone is commercially produced from one source near Sparks. Test wells for oil and gas have been drilled but have shown no production potential.

There are 315 miles of ephemeral, 104 miles of intermittent, and 94 miles of perennial streams in Wolf River Watershed. Five lakes in the watershed have surface areas of 5 acres or larger, covering 27 acres. The watershed includes less than 5 acres of wetlands types 3 through 20 as inclusions with other cover types. 26/ The major source of ground water is the glacial drift underlying most of the watershed. Yield from alluvial aquifers generally is low and varies widely in amount and dependability. There is no irrigation in the watershed. Water quality is also quite variable in bedrock aquifers in the counties. (See references 8/ and 29/ and Tables III, IV, and X, Appendix C, for water data.)

The 1976 recreational use of Atchison, Brown, and Nemaha Counties' lakes was 45,000; 40,000; and 48,000 visits respectively. (See Tables II, Appendix C, and reference 3/ for details of recreational facilities and accommodations in a five-county area including the watershed.) Brown State Fishing Lake is not large enough to meet current need for water-based recreation. All land adjacent to Wolf River is privately owned, and access for recreation is by landowner permission.

The watershed terrestrial wildlife habitat is moderately diversified. (See land cover, Table VI, Appendix C.) Habitat value, by type, is rated as follows: upland woodland, 4,800 habitat units (hu); riparian woodland, 21,900 hu; pastureland, 51,100 hu; and cropland, 118,000 hu. (See page 4 for definition of habitat units).

Forecasted Conditions

Net agricultural income will decline on 19,250 acres of cropland. Gully erosion will cause the conversion of 1,950 acres of cropland to stream channels and/or miscellaneous land. Approximately 3,460 acres of cropland adjacent to these gully areas will be converted from row crop to grassland. Production costs will increase as gullies cause greater machine time and equipment breakage.

Crop Yield - Potential crop yields have increased dramatically over time due to changes in technology. Flood plain yields were

adjusted to reflect application of known technology. Present yields were used for all erosion evaluations such as sheet and rill, ephemeral, gully and depreciated.

Flooding - The area flooded is not expected to change without some type of group project. Installation of the going program practices on about 4,000 acres will reduce flood peaks approximately two percent. The effect of this flood damage reduction was taken out of future without project damages.

Sediment - The erosion cycle is at the point where many more acres will be lost to gullies in the future without the project. This erosion will increase the amount of sediment moving through the system and into the Missouri River.

Water Quality - The amount of suspended solids carried by Wolf River is predicted to increase because of increased erosion and subsequent sediment load due primarily to grade instability and gullying. There would also be a corresponding increase in the amount of nutrients and pesticides that would be transported by the sediment.

Stream Ecosystems - Stream habitat quantity and quality is expected to decline in all evaluation reaches. This habitat degradation is due to loss of pool depth and the continued effects of channelization and improper use of the riparian corridor. Fish population and diversity will continue to decline.

Erosion - Land quality will continue to decline on 21,600 acres eroding at a rate exceeding five tons/acre/year. Soil infiltration rates as a result of erosion will decrease thereby reducing available root zone water and potential crop yields. Conversion of some cropland to grassland and farmers' attempts to stop gullies entering cultivated fields may only slow down the advancing gully or transfer it to another location, not stop it. Erosion will cause a decrease of prime farmland of 230 acres. Numerous gullies will develop in grassed waterways and other conservation system outlet works on 10,800 acres of treated cropland.

Ephemeral Erosion - Ephemeral gully channels along natural water courses erode on untreated cropland fields annually. Time of year, intensity of the rain storm, soil, and slope have an effect on width and depth of soil being eroded. Farmers plow these eroded areas and/or push them in with dozers and disk around them before starting their normal tillage operations. Topsoil is thereby mechanically moved into the water course only to be flushed out during the next storm. Over time many of these ephemerals will become permanent gullies; however, a nearly equal number of acres will become ephemeral drains as the erosion cycle and the water courses move upstream.

Gully Erosion - Wolf River gully development is a result of channel instability and topography. The increase in gully acres is a result of the geometric increase in the number of headcuts versus an arithmetic reduction in the rate at which the gully headcut advances.

The normal slowing of headcut rate by reduction of drainage area is offset in the watershed by a significant increase in gradient as the headcut extends toward the drainage divide. The steeper land produces more erosive power for the same amount of water and drainage area. Approximately 25 percent of the watershed land has slopes greater than 10 percent.

All gullies follow essentially the same geomorphic development and eventually return to relative stability. Stability is reached when the headcut reaches the drainage divide or no longer has sufficient energy to erode.

The physical conditions of Wolf River and its tributaries are such that an explosive increase in gully growth over the next 50 to 75 years is predicted. After that period of time the headcuts will have moved up slope far enough that the amount of water entering water courses will not have as much energy; therefore, the rate of gully growth will decrease. The projections include these considerations.

Table K - Projected Gully Growth

Land Use	1985	1990	2040
		Acres	
Untreated cropland	510	620	1,720
Treated cropland	270	340	920
Other land	130	160	430
Total	910	1,120	3,070

Depreciated Areas - Next to the advancing gully, farmers leave a buffer strip as a means of holding back the advancing gully. In addition, small cropland areas may be cut off, isolated, and left untilled. These areas revert to grass or brush. Some conversion occurs in treated cropland, but most of the area is in untreated cropland. The following table shows the depreciated acres:

Table L - Projected Depreciated Acres

Category	1985	1990	2040
		Acres	
Untreated cropland	1,530	1,860	5,150
Treated cropland	30	40	90
Total	1,560	1,900	5,240

Going Program - The on-going land treatment program with the 1985 Food Security Act will adequately treat sheet and rill and ephemeral erosion on an additional 4,000 acres over the evaluation period. The on-going land treatment program will not provide enough financial or technical assistance to adequately treat approximately 16,500 acres of cropland because of grade instability in drainageway outlets caused by gully erosion. The going program will provide technical assistance on conservation tillage, winter cover crops, and strip cropping. Without project, in order to reduce sheet and rill erosion on highly erodible cropland, farmers would be encouraged to convert to permanent vegetation or increase the amount of wheat, alfalfa, and red clover in their rotation reducing the corn and soybeans produced. This changing of crops produced will reduce immediate farm income while failing to slow the advancement of gully erosion.

Land Use - Compare Table M with Table J to see expected future land use changes. Forty-one small grade stabilization structures will be installed increasing water surface by approximately 40 acres. Urban expansion will cause a decrease of 20 acres in prime farmland. Forestland is projected to decrease by 150 acres.

Table M - Future Land Use Without Project

Land Use	100-Year Flood Plain		Upland		Total	
	%	Acres	%	Acres	%	Acres
Cropland	81	5,680	56	36,690	58	42,370
Pastureland	5	340	29	19,080	27	19,420
Forestland	7	480	5	3,490	5	3,970
Other Land	1	50	5	3,290	5	3,340
Stream Channel and Ponds	6	420	1	450	1	870
Gullies	-	-	4	3,070	4	3,070
TOTAL	100	6,970	100	66,070	100	73,040

Without-project forecasts show a reduction in cropland and an increase in grassland. Gullies are projected to increase significantly. Aquatic species diversity will also be reduced due to deterioration of stream habitat.

Wildlife - Habitat quality will decline for some species. Some fringe areas next to gullies will increase in habitat as it is converted from cropland to grassland. Farmers have had difficulty maintaining grass waterways seeded to brome because of accidental herbicide contact. Current standards recommend seeding grass waterways with native grass mixes. Where native grass is well established wildlife habitat will increase. Many steep back slope terraces, diversions and small structures are currently being seeded to native grass mixes which will increase wildlife habitat.

Table N - Projected Habitat Unit[a/] Changes Without a Project

Land Cover	Average Value	Present Habitat Units	Projected Habitat Units[b/]	Change in Habitat Units	Percent Increase/ Decrease
Cropland	2.5	118,000	104,300	- 13,700	- 12
Pasture-land	3.0	51,100	60,200	+ 9,200	+ 18
Forestland c/	5.7	26,700	26,000	- 700	- 3

a/ Habitat units equal the rated quality value (variable 1 to 10) multiplied by acres.
b/ Assuming the quality factor remains constant.
c/ Includes riparian and upland woodland.

The quality (average value) of permanent wildlife habitat may also decrease in the future due to reduced interspersion (mixing of habitat types) and increased use of herbicides and pesticides. See Tables J and M for acres. See Table VI in Appendix C for a complete habitat evaluation.

Transportation System - The cost of maintaining and replacing bridges will increase in the future without the project as gullies continue to advance. As channels increase in width and depth, more bridge construction materials are required. More repairs are necessary as approaches are undermined and foundations are weakened. Expected life of bridges will be reduced. Some of the bridges will not be replaced and some roads will be closed causing inconvenience and extra travel costs. The opportunity to reduce bridge replacement costs amounts to more than $2.4 million.

Flood Plain Damages - Crop and pasture, other agriculture, road urban, railroad, and flood plain scour were estimated to be more damageable in the future without the project. Future damages were not included in the analyses, however.

Sediment Deposition - This highly erodible watershed yields a significant amount of sediment. Much of it enters the Missouri River where it is distributed downstream, including the lower Mississippi River. Some sediment is dredged to keep the waterway open for river transportation. Farm ponds collect the next largest amount of sediment. Once these ponds are filled with sediment farmers generally construct another pond upstream; however, they could dredge out the sediment and restore the pond to its original capacity. Flood plain sediment deposits are generally disposed of during the normal tillage operations. Sediment deposition in road ditches require periodic clean out using a large loader and trucks to haul the sediment away. Sediment deposited at the ends of fields is generally left where

deposited and incorporated into the field using regular tillage equipment.

Table O - Projected Sediment Deposition

Category	Tons Per Year	Acre Feet
Upland Cropland	8,400	5
Road Ditches	11,800	7
Wolf River Tributaries a/	negligible	--
Missouri River	382,100	320
Ponds	117,600	90
Flood Plain	94,700	57
Total	614,600	479

a/ Sediment is flushed through the system. Negligible deposition occurs in tributary channels.

FORMULATION OF ALTERNATIVES

Formulation Process

The Economic and Environmental Principles and Guidelines for water and related land resource implementation studies contain the broad objective to contribute to national economic development consistent with protecting the nation's environment. This objective is to increase the value of the nation's output of economic goods and services or to improve economic efficiency. Protection of the nation's environment is to conserve and/or preserve the nonmonetary aspects of man's surroundings such as cultural resources, ecological systems, or natural resource qualities.

Early in the formulation process, sponsors listed the problems and opportunities in the watershed. Public input plus interdisciplinary and interagency planning produced the final list of problems and opportunities shown in the first column of Table P, page 37.

The major problem identified was reduced agricultural income directly related to flooding and erosion. Measures were considered to reduce flood damages and erosion and to increase agricultural income. Nonstructural measures were considered first, but none were found to increase agricultural income. Grade stabilization dams with additional flood control features combined with land treatment will decrease flood damages, reduce erosion and, as a result, provide the stability needed for equilibrium and an increase in agricultural income.

Opportunities to improve wildlife habitat for environmental quality could best be accomplished by land use changes and improved management practices including native grass. Opportunities to reduce sediment yield, gullies, scour, and other erosion and improve downstream aquatic habitat could best be met by grade stabilization structures combined with land treatment and improved management practices.

Project scoping began with a list of those measures that would help achieve or could be expected to satisfy one or more of the problems and opportunities (Table P). Those measures are defined below:

(a) Accelerated land treatment: The accelerated land treatment program consists of the installation of resource management systems on cropland, grassland, and woodland at an accelerated rate over that available through the going program (all available programs of technical and financial assistance except P.L. 566). A resource management system is a combination of conservation practices and management measures used to maintain or improve soil, water, plant, and animal resources.

(b) Grade stabilization dams: Grade stabilization structures are designed to stop gully erosion and provide storage for sediment and floodwater. Principal spillways and detention storage would be sized to provide downstream flood protection. The dams and sediment pools would be located and sized to stop gully advance. Required land treatment is considered part of this measure for formulation purposes. Required land treatment includes those practices necessary to reduce sheet and rill erosion so that the dam will be functional for its design life. In addition, it is that amount of treatment required to realize the evaluated economic benefits. The ability of the grade stabilization structures to control runoff, reduce gullying, and store sediment are the key ingredients to reducing damages due primarily to sediment and attached or associated pollutants. These are essential components to controlling pollutants and enhancing water quality.

(c) Change in flood plain land use and/or management: This practice includes converting the use of some flood plain from cropland to grassland.

(d) Change in land use and/or management: This practice includes converting the use of some cropland to grassland or to a cropping system of alfalfa, red clover, and wheat.

(e) Multi-purpose dam: This type dam has a designed storage quantity for more than one purpose such as floodwater, water supply, and recreation water.

Analysis was made of the expected impact of each measure under consideration on each of the problems or opportunities. Table P summarizes the results of this effort and shows the basis for selection of combinations of measures to be included in alternative plans. It also shows reasons some measures were not studied further. Formulation of the NED and other plans are discussed in more detail on the following pages.

The ability of the going program of land treatment to solve watershed problems and fulfill opportunities was assessed early. About 20,500 acres of untreated cropland above gully problem areas were found to have special land treatment needs. Advancing gullies restrict treatment of these areas because stable outlets are not available for waterways or underground outlets. Some gullies can be treated with land treatment funds available to individual farmers, but many require cooperative agreements with several landowners.

Table P - Measures[a/] to Satisfy Problems and Opportunities

Problems and Opoortunties	Accelerated Land Treatment	Grade Stabilization Dams	Change Flood Plain Land Use and/or Management	Change Upland Land Use and/or Management	Multi-purpose Structure
To increase agricultural income:					
Reduce soil loss on 21,600 acres	+	+	N	-	N
Stabilize gullies that restrict use and treatment of 27,300 acres	N	+	N	-	N
Maintain erosion control practices on 39,600 acres	N	+	N	-	N
Reduce flooding on 6,970 acres	+	+	-	-	+
Reduce other flood damages on 22 farms	+	+	+	N	+
Reduce flood damages to roads/ bridges/railroads	+	+	N	N	+
Reduce scour erosion on 420 acres of flood plain	+	+	-	-	+
Achieve adequate fire protection	+	N	N	N	N
To increase recreation services:					
Provide 25,000 water-based recreational opportunities	N	N	N	N	+
To enhance environmental values:					
Improve stream aquatic habitat	+	+	+	+	+
Improve wildlife habitat	+	-	+	+	-
Increase habitat diversity	+	-	+	+	+
Protect woody riparian habitat	N	-	+	N	-
Reduce sediment yield	+	+	+	+	+
Reduce sediment deposition on flood plain	+	+	+	+	+
Reduce erosion in forestland	+	N	N	+	N
Achieve adequate fire protection	+	N	N	+	N
Reduce soil loss on 21,600 acres	+	+	N	+	N
Stabilize gullies	+	+	N	N	N

a/ See narrative for definition of each measure

(+) favorable impact (N) no impact or negligible impact (-) adverse impact

One hundred fifteen grade stabilization problem areas were identified through studies made by soil scientists, geologists, engineers, agronomists, district conservationists, and farmers. In the affected area advancing gullies destroy waterways and preclude installation of terraces and other mechanical type conservation practices.

The most effective alternative to maintain or increase farm income in these problem areas is seen to be grade stabilization structures (reservoir type) to provide stable water outlets for land treatment. Historically, the smaller grade stabilization problems have been corrected by individual landowners. Therefore, a screening procedure was developed to measure the severity and extent of the erosion problem and indicate whether project action was appropriate or whether individual on-farm action could be expected to solve the problem. Ninety-seven problem areas met the criteria for project action and were evaluated further. Some problem areas were treated by landowners with private and state funds while others were too costly to treat with P.L. 566 funds. For these reasons this analysis was restricted to measure the economic significance of 83 of the 97 problem areas. Land treatment needs were identified and costs estimated. Grade stabilization and flood prevention benefits were computed and allocated to each problem area.

Each grade stabilization dam was designed to retard floodwater in addition to controlling channel grade. A hydrologic analysis was made of all proposed structures to measure their individual and cumulative reductions of flood damage. Flood damage reduction benefits were identified for crop and pasture, other agricultural, road and bridge, railroad, urban, land scour, sediment, and other direct damages. Benefits to each flood plain reach were thus allocated to each structure for the various alternatives studied.

Four alternatives were formulated by combining various measures to solve problems and realize opportunities. These alternatives are: (1) No Project - the going conservation program including limited use of area affected by gullies; (2) the NED plan - 11 large grade stabilization dams, land treatment structure systems at 25 erosion problem areas, required land treatment, and accelerated land treatment on 1,890 acres; (3) the recommended plan - 16 large grade stabilization dams, land treatment structure systems at 42 ersoion problem areas, required land treatment, and accelerated land treatment on 1,890 acres; and (4) the Resource Protection Plan - 29 large grade stabilization dams, land treatment structure systems at 54 erosion problem areas, and 1,890 acres of accelerated land treatment.

The NED alternative was formulated using a step-by-step incremental analysis starting with the 83 previously identified problem areas. Structures with good economic feasibility potential were grouped by watershed subarea (the eight subareas are coincident with the project evaluation reaches). The benefits and costs of each individual subareas system were evaluated The subarea structure

systems were arrayed in accordance with the highest net benefit with the strongest (most net benefit) at the top of the list. The weakest increments were dropped and the remaining systems tested for net benefits. This process was repeated for systems of structures until a loss of net benefits was encountered.

Field investigations were made to determine available alternatives to the large grade stabilization dams. Twenty of the 83 erosion problem areas were studied in detail. The findings for these areas were extrapolated to the remaining problem areas. It was found that gully growth could be significantly reduced, and in some cases stopped by installing off-channel land treatment structures such as small grade stabilization structures, water and sediment control basins, and diversions along the channel. Gully growth would continue in the main channel. In some cases, however, the off-channel land treatment structures would be attacked by the gully and fail before a 25-year expected life. Recognizing these limitations a comparison was made between the large grade stabilization dams and the land treatment structure systems.

The geologist and hydrologist measured the effectiveness of the land treatment structures in relationship to what the large grade stabilization dams would do. The economist used these physical effects for measuring the economic effects. Grade stabilization dams with positive net benefits were included in the NED plan. Land treatment systems were tested for the remaining watershed problem areas and included in the NED plan if positive net benefits occurred.

The following table shows the results of the incremental analysis:

Table Q - Incremental Analysis of Structural Measures

Alternatives	Total Costs $	Incremental Cost $	Total Benefits $	Incremental Benefits $	Net Benefits $
10 Dams - 25 Land Treatment Structure Systems	337,500	-	423,300	-	85,800
11 Dams - 25 Land Treatment Structure Systems	354,500	17,000	440,800	17,500	86,300
12 Dams - 25 Land Treatment Structure Systems	365,100	10,600	447,400	6,600	82,300
16 Dams - 42 Land Treatment Structure Systems	563,000	197,900	608,400	161,000	45,400
29 Dams - 54 Land Treatment Structure Systems	912,500	349,500	807,500	199,100	-105,000

Table R - Incremental Analysis of Land Treatment Measures[a/]

Practices	Sheet and Rill Erosion b/ Remain Tons/ Ac.	Sheet and Rill Erosion b/ Reduct Tons/ Ac.	Sheet and Rill Damage Remain $	Sheet and Rill Damage Reduct $	Ephemeral Erosion b/ Remain Tons/ Ac.	Ephemeral Erosion b/ Reduct Tons/ Ac.	Ephemeral Damage Remain $	Ephemeral Damage Reduct $	Gullies Deprec. $	Water Cons. $	Flood/ Road $	Incremental Costs $	Incremental Bene. $	Net Bene. $	B/C Ratio
EVALUATION UNIT 1															
W/O Treatment	16.0	-	11.71	-	4.5	-	11.51	-	24.99	12.85	34.51	-	-	-	-
Conservation Till (CT)	6.5	9.5	5.56	6.15	3.6	0.9	9.22	2.29	1.47	3.12	-	-	13.03	13.03	-
Contour Farm (CF)	12.8	3.2	9.02	2.69	3.5	1.0	8.96	2.55	-	-	-	4.32	5.24	0.92	1.21:1
Terraces (T)	6.2	9.8	3.45	8.26	0.9	3.6	2.31	9.20	6.61	7.01	2.65	23.21	33.74	10.53	1.45:1
Water & Sediment Control Basins (W&S)	16.0	-	11.71	-	4.5	0.22	10.95	0.56	2.88	-	2.12	2.50	5.56	3.05	2.22:1
Grade Stab. Dams (GS)	16.0	-	11.71	-	4.5	-	11.51	-	19.92	-	22.58	29.65	42.50	12.85	1.43:1
Diversions (D)	16.0	-	11.71	-	4.5	-	11.51	-	5.81	-	3.09	7.48	8.90	1.42	1.19:1
CT & T	2.3	13.7	0.16	5.39	0.7	3.8	1.80	7.42	6.25	5.06	5.34	23.21	29.46	6.25	1.27:1
CT & W&S	6.5	9.5	5.56	-	3.6	1.0	8.66	0.56	2.88	-	4.80	2.50	8.24	5.74	3.30:1
CT & GS	6.5	9.5	5.56	-	3.6	0.9	9.22	-	17.18	-	22.55	29.65	40.73	11.08	1.37:1
CT & D	6.5	10.2	4.96	0.59	3.6	0.9	9.22	-	4.85	-	5.69	7.43	11.12	3.64	1.49:1
CT, W&S, & D	5.8	10.2	4.96	0.59	3.6	1.0	8.66	-	3.62	2.33	3.19	7.48	9.73	2.25	1.30:1
CT, W&S, D, & T	2.1	13.9	-	4.96	0.7	3.8	1.81	6.85	4.83	6.62	2.35	23.21	25.61	2.40	1.10:1
CT, W&S, D, T, & GS	2.1	13.9	-	-	0.7	3.8	-	1.81	12.18	0.78	24.11	29.65	38.88	9.23	1.31:1
EVALUATION UNIT 2															
W/O Treatment	21.0	-	8.77	-	4.1	-	12.31	-	20.10	12.85	31.54	-	-	-	-
Conservation Till (CT)	8.8	12.2	2.99	5.78	3.3	0.8	9.91	2.40	2.00	2.05	3.56	-	15.89	15.89	-
Contour Farm (CF)	16.9	4.1	6.83	1.94	3.5	0.6	10.51	1.80	-	1.54	3.65	4.32	8.94	4.62	2.07:1
Terraces (T)	7.9	13.1	2.56	6.21	0.8	3.3	2.41	9.90	5.28	8.51	3.66	49.13	33.55	-15.57	0.68:1
Water & Sediment Control Basins (W&S)	21.0	-	8.77	-	4.1	0.20	11.71	0.60	2.53	-	2.83	5.62	5.95	0.34	1.06:1
Grade Stab. Dams (GS)	21.0	-	8.77	-	4.1	-	12.31	-	8.99	-	11.10	15.44	20.09	4.65	1.30:1
Diversions (D)	21.0	-	8.77	-	4.1	-	12.31	-	4.80	-	2.83	3.85	7.63	3.77	1.98:1
CT & T	2.8	18.2	0.14	2.85	0.6	3.5	1.81	8.10	3.78	8.82	3.53	49.13	27.13	-22.00	0.55:1
CT & W&S	8.8	12.2	2.99	-	3.3	1.0	9.31	0.60	1.86	-	2.65	5.62	5.32	- 0.30	0.95:1
CT & GS	8.8	12.2	2.99	-	3.3	0.8	9.91	-	7.49	-	18.53	15.44	26.02	10.58	1.69:1
CT & D	7.8	13.2	2.52	0.47	3.3	0.8	9.91	-	3.29	-	2.86	3.85	6.62	2.76	1.72:1
CT, D, & T	2.5	18.5	-	2.52	0.6	3.5	1.81	8.10	2.51	9.05	3.65	49.13	25.84	-23.29	0.52:1
CT, D, & W&S	7.8	13.2	2.52	-	3.3	1.0	9.31	0.60	2.53	-	2.76	5.62	5.89	0.27	1.05:1
CT, D, & GS	7.8	13.2	2.52	-	3.3	0.8	9.91	-	7.00	-	18.51	15.44	25.51	10.07	1.64:1
CT, D, T, & GS	2.5	18.5	-	2.52	0.2	3.9	1.81	8.10	5.45	-	3.65	49.13	19.73	-29.40	0.40:1
CT, D, T, W&S, & GS	2.5	18.5	-	-	0.2	4.1	-	1.81	1.52	-	3.75	5.62	7.03	1.46	1.25:1
EVALUATION UNIT 3															
W/O Treatment	58.0	-	9.97	-	8.0	-	8.72	-	24.43	10.07	26.02	-	-	-	-
Conservation Till (CT)	23.3	34.7	3.16	6.81	6.8	1.2	5.42	1.45	3.89	1.68	0.49	-	14.32	14.32	-
Terraces (T)	20.6	37.4	2.63	7.34	1.2	6.8	0.48	8.24	16.46	9.51	2.49	54.64	44.04	-10.60	0.81:1
Water & Sediment Control Basins (W&S)	58.0	-	9.97	-	8.0	0.4	8.29	0.43	2.99	-	2.49	1.53	5.91	4.38	3.85:1
Grade Stab. Dams (GS)	58.0	-	9.97	-	8.0	-	8.72	-	9.53	-	16.13	16.86	25.65	9.10	1.55:1
Diversions (D)	58.0	-	9.97	-	8.0	-	8.72	-	6.86	-	2.49	17.53	9.25	- 8.23	0.53:1
CT & D	20.6	37.4	2.62	0.54	6.8	1.2	5.42	-	2.97	-	2.62	17.53	6.13	-11.45	0.35:1
CT, W&S, & D	20.6	37.4	2.62	-	6.8	1.6	5.12	0.30	0.47	-	2.37	1.53	3.14	1.61	2.05:1
CT, W&S, GS, & T	7.2	50.8	-	2.62	0.8	7.2	-	6.97	15.50	8.39	15.53	54.64	49.17	- 5.47	0.90:1
CT, W&S, GS, T, & D	7.2	50.8	-	-	0.8	7.2	-	-	1.61	-	4.92	17.53	6.53	-11.05	0.37:1

a/ Benefits and costs are average annual dollars per acre based on 8 5/8 percent interest for 50 years
b/ Erosion rates are expressed as the nearest whole ton but are shown to the nearest tenth of a ton to depict effects

The land treatment incremental analysis was done for three evaluation units. These were soils in similar slope groups that required the same kind of treatment. The three slope groups (evaluation units) were five percent, seven percent and greater than 10 percent. The following tables shows the land treatment incremental analysis.

The Resource Protection alternative was formulated to achieve the sponsors' objective of maximizing protection to the watershed resource base. This alternative was formulated to address concerns not fully addressed by the NED plan. The parameters selected to measure resource protection were sheet and rill erosion, ephemeral erosion, gully erosion, depreciated area (unfarmable areas adjacent to gullies), vehicles per day (road use affected by the problem area), terrestrial wildlife habitat loss, and net economic benefits. A composite was made for all categories. Each problem area was ranked on its ability to provide resource protection based on the net economic benefit per unit of measure.

The resource protection analysis described above was made for both the grade stabilization dam and the land treatment structure system for each problem area. In all cases the grade stabilization dams provided the most resource protection, but in some cases were less effective because of low net economic benefits.

The Recommended Plan is a blending of the NED plan and the Resource Protection Plan. The watershed sponsors wish to achieve as much watershed resource base protection as possible with available funds. Grade stabilization dams with benefit-cost ratios between 0.8 and 1.0 were added to the NED plan system thereby providing more resource protection.

An interagency, interdisciplinary team formed in accordance with the WRC Principles and Guidelines and SCS NEPA regulations, determined the scope of the environmental evaluation. The team considered each environmental problem and opportunity to identify an element or measure to best meet that need (See Table P for the list of environmental problems and opportunities). Some elements were found to meet more than one environmental objective.

One site near Leona was investigated for feasibility of recreational development. Kansas Fish and Game Commission, Kansas Park and Resources Authority, and SCS assisted sponsors to determine the need for water-based recreational facilities using the Comparable Demand Method. The analysis showed a need of about 25,000 annual recreation visits for boating and fishing. Recreation benefits computed for this amount of use would not offset costs.

Evaluation of Alternatives

Alternatives considered during planning are described in this section. Costs and economic, environmental, and social impacts of

greatest significance to decision making are compared in Table S, and in Appendix C. Two maps following this page show alternatives for the National Economic Development Plan (NED) and the Resource Protection Plan. The project map, Appendix D, shows the Recommended Plan alternative.

Alternative 1 (No Project) consists of continuing the present conservation program without project action. Land treatment would be applied on 4,000 acres of cropland and 2,040 acres of pastureland in addition to areas presently treated. Conservation tillage would be practiced on 21,300 acres (including some of the above cropland area).

Alternative 2 is the National Economic Development Plan (NED). This plan includes the going program, 11 grade stabilization dams, land treatment structure systems at 25 erosion problem areas, required land treatment, forestry land treatment on 2,660 acres, and accelerated land treatment on 1,890 acres of cropland.

Costs: Total project costs - $5,299,900; PL 83-566 share - $4,214,200; other - $1,085,700; average annual cost - $354,500; operation, maintenance, and replacement cost - $61,200.

Effects: This alternative would reduce sediment yield to Missouri River by 56,700 tons or 15 percent, scour by 6,100 tons on 185 acres, gully erosion by 56,700 tons and preserve 580 acres, depreciated area by 980 acres, ephemeral erosion by 44,700 tons on 100 acres, sheet and rill erosion by 135,600 tons; terrace 5,800 acres of cropland; and provide stable water outlets for 5,500 acres of terraced cropland. The 100-year flood plain would be reduced about 810 acres. Overall flood damages would be reduced 5 percent. Average annual benefits of $440,800 would accrue at an annual cost of $354,500. The net benefit to this alternative would be $86,300.

Alternative 3 is the Recommended Plan. This plan includes: the going conservation program; 16 grade stabilization dams and land treatment; land treatment structure systems and required land treatment at 42 erosion problem areas; accelerated land treatment on 1,890 acres of cropland; and treatment of 2,660 acres of forestland for continued high quality timber production. Practices to be installed in each evaluation unit are detailed in Table 1.

Costs: Total project costs - $8,584,700; PL 83-566 share - $6,817,800; other - $1,766,900; average annual cost - $563,000; operation, maintenance and replacement cost - $96,000.

Effects: This alternative will reduce sediment yield to the Missouri River by 166,800 tons or 44 percent, scour by 9,500 tons or 290 acres, gully erosion by 148,300 tons and preserve 1,100 acres, depreciated area by 1,870 acres, ephemeral erosion by 50,300 tons or 105 acres, sheet and rill erosion by 224,000 tons; terrace 9,800 acres of cropland; and provide stable water outlets for 9,400 acres of terraced cropland. The 100-year flood plain will be reduced about 1,350 acres. Overall flood damages will be reduced 6 percent. Average annual

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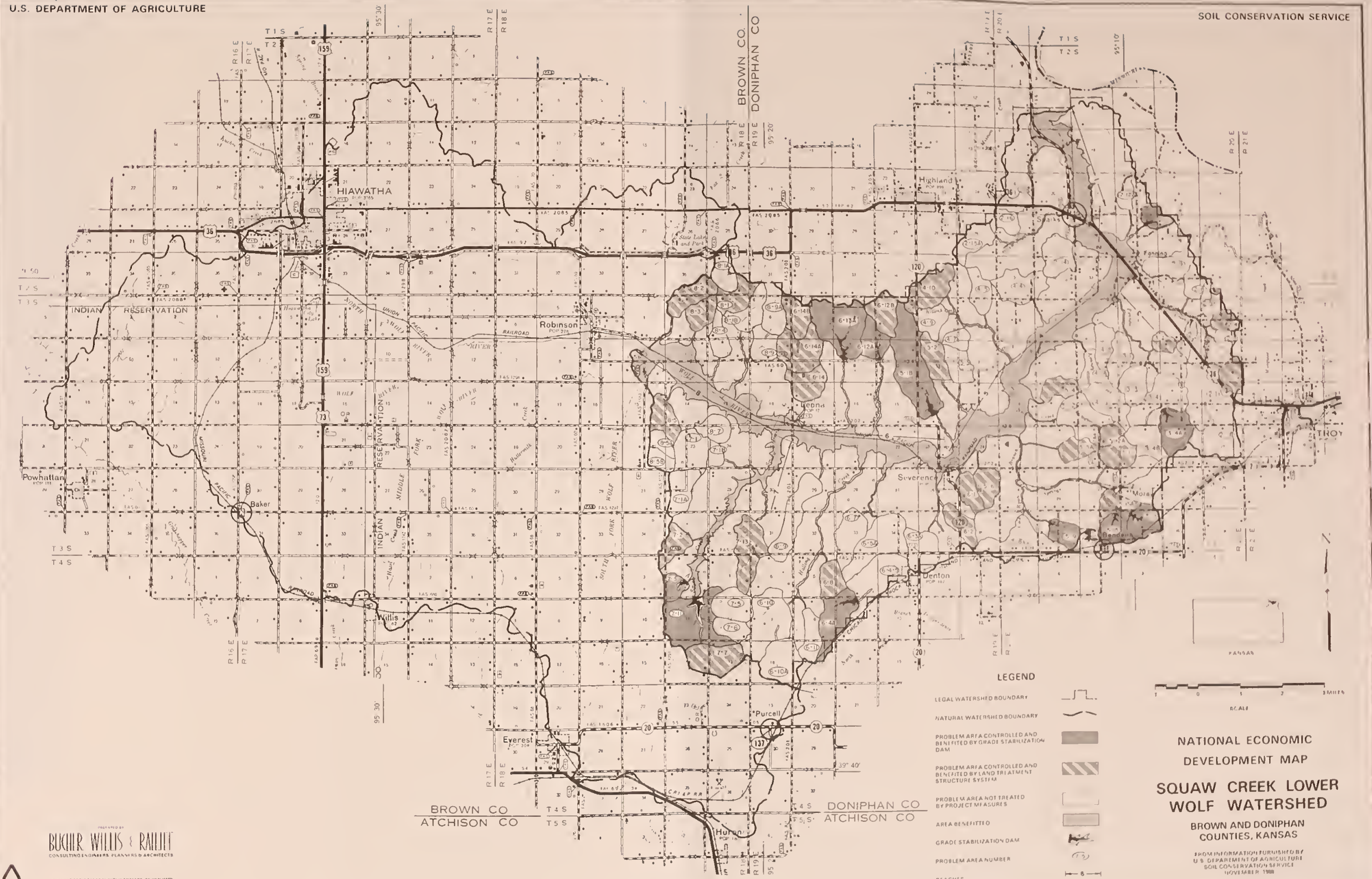

NATIONAL ECONOMIC DEVELOPMENT MAP

SQUAW CREEK LOWER WOLF WATERSHED

BROWN AND DONIPHAN COUNTIES, KANSAS

FROM INFORMATION FURNISHED BY U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE NOVEMBER 1980

PREPARED BY

BUCHER, WILLIS & RATLIFF

CONSULTING ENGINEERS, PLANNERS & ARCHITECTS

PREPARED FROM GENERAL HIGHWAY MAPS, BROWN (1977), DONIPHAN (1977) AND ATCHISON (1978) COUNTIES, KANSAS

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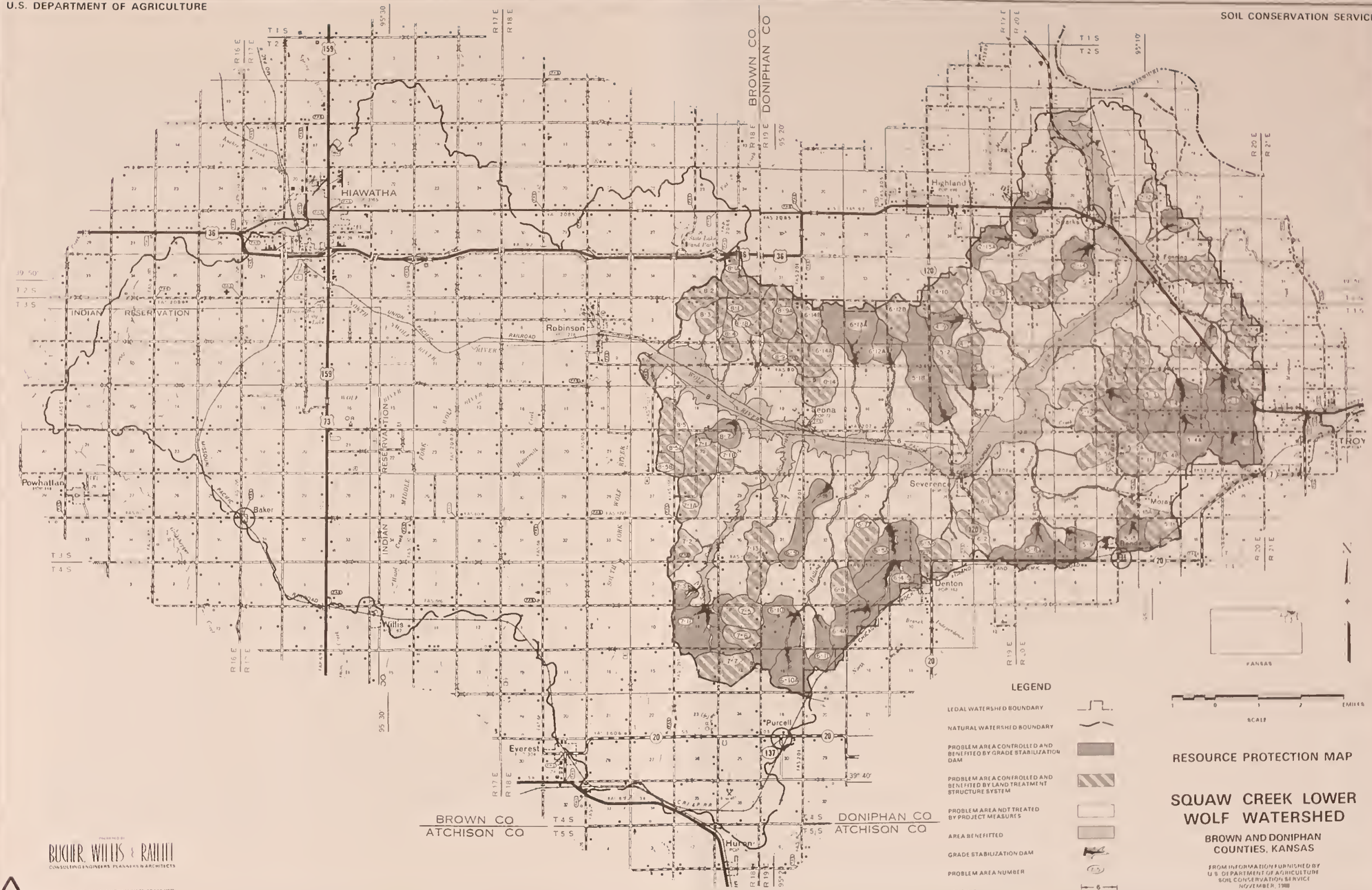

RESOURCE PROTECTION MAP

SQUAW CREEK LOWER WOLF WATERSHED

BROWN AND DONIPHAN COUNTIES, KANSAS

FROM INFORMATION FURNISHED BY U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE NOVEMBER, 1980

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PREPARED FROM GENERAL HIGHWAY MAPS, BROWN (1977) DONIPHAN (1977) AND ATCHISON (1978) COUNTIES, KANSAS

benefits of $608,400 will accrue at an annual cost of $563,000. The net benefit to this alternative would be $45,400.

Alternative 4 is the Resource Protection Plan. This plan includes: the going program; 29 grade stabilization dams and required land treatment; land treatment structure systems and required land treatment at 54 problem areas; 1,890 acres of accelerated land treatment and forestland land treatment on 2,660 acres.

Costs: Total project costs - $14,120,500; PL 83-566 share - $11,494,100; other - $2,626,400; average annual cost - $912,500; operation, maintenance, and replacement cost $152,900.

Effects: This alternative would reduce sediment yield to the Missouri River by 209,900 tons or 55 percent, scour by 11,900 tons on 365 acres, gully erosion by 236,700 and preserve 1,600 acres, depreciated area by 2,730 acres, ephemeral erosion by 43,500 tons on 90 acres, sheet and rill erosion by 178,200 tons; terrace 13,600 acres of cropland; and provide stable water outlets for 12,100 acres of terraced cropland. The 100-year flood plain would be reduced about 1,490 acres. Overall flood damages would be reduced 7 percent. Average annual benefits of $807,500 would accrue at an annual cost of $912,500. The net benefit to this alternative would be - $105,000.

Comparison of Candidate Plans

The Recommended Plan was selected by sponsors after consideration of preferences expressed by the public, their financial resources, and their assessment of the social impact of land rights acquisition. Maintenance and enhancement of the soil resource base weighed heavily in the sponsors' decision.

The Formulation of Alternatives section provides more insight into deliberations about these objectives and related plan elements. Table S shows a comparison of impacts of the alternatives.

Because Alternative 1 would have virtually no impact on any of the planning objectives nor on any key environmental issues, the sponsors did not consider no-project-action as a viable alternative.

The going programs for soil conservation and forestry technical assistance will continue to improve resource protection. Average annual soil resource loss and flood damage can be expected to continue at a cost of $1,497,900.

The NED Plan includes 11 grade stabilization dams and 25 land treatment structure systems. Many stream channels would continue to erode causing upstream road crossings to fail. This plan would not provide for terracing of 2,400 acres of steep (7 percent and greater) land because of unstable water outlets that the Recommended Plan would treat. It costs about $3,284,800 less than the Recommended Plan. The going program would continue.

Table S - Summary and Comparison of Candidate Plans

Effects	Without Project	Alternative 2 NED Plan	Alternative 3 Recommended Plan	Alternative 4 Resource Protection Plan
Measures	Continue going land treatment program	Continue going, program, terrace 5,800 acres of cropland, provide stable water outlets for 5,500 acres of terraced cropland, accelerated land treatment 1,890 acres, 2,660 acres of forestland treatment	Continue going program, terrrace 9,800 acres of cropland, provide stable water outlets for 9,400 acres of terraced cropland, accelerated land treatment 1,890 acres, 2,660 acres of forestland treatment	Continue going program, terrace 13,600 acres of cropland, provide stable water outlets for 12,100 acres of terraced cropland, accelerated land treatment 1,890 acres, 2,660 acres of forestland treatment
Problem Areas Treated	0	36	58	83
Project Investment	0	5,299,600	8,584,700	14,120,500
National Economic Development Account				
Adverse, Annualized	-	354,500	563,000	912,500
Beneficial, Annualized	-	440,800	608,400	807,500
Net Beneficial	-	86,300	45,400	-105,000
Environmental Quality Account				
Beneficial				
Going Program Effects	Treat 4,000 acres of cropland and 2,040 acres of grassland; construct 41 dams	Treat 4,000 acres of cropland and 2,040 acres of grassland; construct 41 dams	Treat 4,000 acres of cropland and 2,040 acres of grassland; construct 41 dams	Treat 4,000 acres of cropland and 2,040 acres of grassland; construct 41 dams
Tons Sheet and Rill Erosion	728,500	592,900	554,300	550,300
Ephemeral Gully Area				
Affected Acres	990	400	270	245
Voided Acres	90	190	195	200
Gully Acres	3,070	2,490	1,970	1,470
Depreciated Acres	5,240	4,260	3,370	2,510
Protected Flood Plain	220	810	1,350	1,490
Scour Acres	460	275	170	95
Tons Sediment Yield	382,100	325,400	215,300	172,200
Percent Sediment Yield Reduction	10	15	44	55
Convert Cropland to Water a/	10	35	46	75
Convert Grassland to Water a/	13	89	126	212
Convert Forestland to Water a/	17	46	56	88

Table S - Summary and Comparison of Candidate Plans, Continued

Effects	Without Project	Alternative 2 NED Plan	Alternative 3 Recommended Plan	Alternative 4 Resource Protection Plan
EQ Account, cont'd.				
Adverse				
Convert Cropland to Water a/	10	35	46	75
Convert Grassland to Water a/	13	89	126	212
Convert Forestland to Water a/	17	46	56	88
Convert Ephemeral Streams to Water (miles)	b/	0.2	3.6	2.9
Convert Intermittent Streams to Water (miles)	b/	3.4	9.9	8.0
Convert Perennial Streams to Water (miles)	b/	0	0	0.2
Other Social Effects				
Beneficial				
Going Program				
Cropland Treated	4,000	4,000	4,000	4,000
Grassland Treated	2,040	2,040	2,040	2,040
Accelerated Program				
Cropland Treated	0	1,890	1,890	1,890
Project Action				
Cropland Treated	0	4,800	8,810	12,700
Forestland Treated	0	2,660	2,660	2,660
Protection of Road Crossings (vehicles per day)	1,400	2,900	3,700	10,000
Wildlife Habitat Units	192,900	198,000	200,000	201,000
Regional Economic Development				
Positive Effect				
Annualized	b/	440,800	608,400	807,500
Region	b/	440,800	608,400	807,500
Rest of Nation	b/	0	0	0
Negative Effect				
Annualized	b/	354,500	563,000	912,500
Region	b/	121,300	192,100	294,200
Rest of Nation	b/	233,200	370,900	618,300

a/ Acres converted to water for the 41 grade stabilization structures are included in Alternatives 2 and 4
b/ Not measured

The Recommended Plan, Alternative 3, includes 16 grade stabilization dams at most of the critical problem area locations and 42 land treatment structure systems. Flood damages will be reduced 6 percent. The erosion rate on about 10,700 acres will be reduced from 26 to 5.0 tons per acre per year. The soil resource on 26,000 acres used for crops and 2,660 acres of forestland will be protected for long-term productivity. About 9,400 acres of terraced fields will have stable water outlets. Cost sharing and technical assistance is included to adequately protect 10,700 acres to be treated and about 9,400 acres currently treated.

The Resource Protection Plan, Alternative 4, was formulated to protect each of the 83 erosion problem areas in the most efficient manner either by a grade stabilization dam or land treatment structure system. All of these areas are protected to some degree. The plan meets the maximum objectives of the sponsors of any available alternatives. Erosion will continue, but at a much slower rate than without the plan. This alternative will cost about $5,535,800 more than the Recommended Plan.

The plan includes 29 grade stabilization dams and 54 land treatment structure systems. Flood damages will be reduced 7 percent. The sheet and rill erosion rate on about 13,600 acres will be reduced from 35 to 5.4 tons per acre per year. The soil resource on 25,700 acres used for crops and 2,660 acres of forestland will be protected for long-term productivity. About 12,100 acres of terraced fields will have stable water outlets. Cost sharing and technical assistance is included to adequately protect 13,600 acres to be treated and about 12,100 acres currently treated.

Project Interaction

Wolf River empties into the Missouri River. No other federal agency has proposed dam construction or dredging within the watershed; therefore, there is no conflict with any other plan.

Risk and Uncertainty

Benefits expected to accrue to the planned measures depend upon the installation of the complete plan. Due to the large number of landowners involved there is some uncertainty as to whether all measures will be installed. However, due to landowner acceptance of soil conservation measures and the record of their willingness to install conservation practices it is believed that the planned measures will be installed. Available cost-share funds have traditionally been readily used in the counties involved as is expected with funds to be made available through the project.

The planned measures and funds have been tailored to maintain the highest level of long-term protection to the watershed resource base given the present fiscal limitations imposed by P.L. 566. The construction of structural and land treatment measures was scheduled so as to complement each system and cause the greatest benefit.

The analysis of the plan assumed no dramatic changes in technology, crop prices, food consumption, government programs, or agriculture in general. Any large scale change in any of these categories is not expected, but could have an impact on the project.

Rationale for Plan Selection

The primary objective of the sponsors is to protect and maintain as much of the resource base as possible from further impacts of erosion while keeping project benefits above project costs. The Recommended Plan differs from the NED plan which has maximum net economic benefits as its primary objective.

The sponsors wish to reduce gully, sheet, and rill erosion and ephemeral gully erosion as much as possible. They want to reduce grade instability as much as they can because stable grades are critical to the installation of land treatment practices. They have a limited tax base on which to operate. For this reason they are anxious to select a system that can reduce their operating costs and still control erosion. The sponsors also want to reduce road maintenance cost.

The increasing erosion from gullies due to grade instability surpasses other erosion sources such as sheet and rill, ephemeral gully, scour, and streambank erosion. Over one-third of the watershed is affected by gullying. It therefore becomes vital that the gullying process be slowed. Sediment causes the largest amount of damage resulting in various designated water uses not being met. Other pollutants such as phosphorus, nitrates, and pesticides are associated indirectly with this process.

The State of Kansas has an active interest in soil and water resource protection. The State Water Plan calls for increased efforts by federal, state, and local programs to control soil erosion and to maintain and improve water quality and quantity. The recommended plan takes a more positive step in that direction for the Squaw Creek Lower Wolf Watershed than the NED Plan.

The NED plan includes 11 grade stabilization dams, the recommended plan 16; NED plan - 25 land treatment structure systems, recommended plan - 42; NED plan - treats 6,600 acres, recommended plan - 10,700; NED plan - protects 810 acres of flood plain, recommended plan - 1,350; NED plan - total project costs of $5,299,900, recommended plan - $8,584,200; NED plan - P.L. 566 costs of $4,214,200 and other costs of $1,085,700, recommended plan - $6,817,800 and $1,766,900 respectively; NED plan - annual costs of $354,500, annual benefits of $440,800, and net benefits of $86,300, recommended plan - $563,000; $608,400, and $45,400 respectively; NED plan - operation, maintenance, and replacement costs of $61,200, recommended plan - $96,000.

The recommended plan provides the following additional benefits over the NED plan: Sheet and rill erosion will be reduced an

additional 38,600 tons annually and ephemeral erosion by 5,600 tons annually; 520 acres of gullies and 890 acres of depreciated acres will be protected beyond NED levels. Five hundred forty more acres of flood plain will be protected. One hundred five additional acres of scour will be eliminated. Sediment yield would be reduced an additional 110,100 tons annually. An additional 4,000 acres of cropland will be treated with the recommended plan.

The recommended plan has the following adverse impacts in comparison to the NED plan. The recommended plan costs an additional $3,284,800. The recommended plan will convert an additional 10 acres cropland, 30 acres grassland, and 10 acres of forestland to water. There will be $208,500 of additional annual costs incurred while only $167,600 of benefits will be realized. The additional benefits divided by additional costs equals a 0.8:1 benefit to cost ratio. There will be $3,500 of economic benefits sacrificed by the recommended plan because of land being inundated by water.

The recommended plan treats 5 of the problem areas included in the NED plan in a different manner. The more permanent solution of grade stabilization dams is used rather than land treatment grade stabilization structures. The grade stabilization dams involve higher installation cost and reduced operation, maintenance, and replacement cost. The land treatment grade stabilization structures can be built with less first cost, but require greater operation, maintenance, and replacement cost due to lesser designed sediment and flood storage capacity. The land treatment grade stabilization structures require more frequent replacement due to storage capacities and metal pipe materials used.

The recommended plan treats 22 more problem areas than the NED plan at a cost of $3,284,700. Five dams and 17 LT systems are used to treat the 22 additional problem areas. The dams will protect 7 road crossings with an estimated use of 300 vehicles per day. Road and bridge maintenance costs will be reduced by $15,700 and downstream bridge construction will be reduced by $4,800. The 17 LT systems will provide partial protection to 23 road crossings with an estimated use of 500 vehicles per day. Road and bridge maintenance costs will be reduced by $36,000 and downstream bridge construction savings of $12,200. This treatment will stop projected gully growth of 520 acres and permit terrace installation of 4,000 acres. An additional 3,900 acres of terraced cropland will have stable water outlets.

Physical conditions, such as the large amount of steep land (25 percent of the watershed greater than 10 percent slope) and the highly-erodible nature of the deep loess soils, contribute to grade instability being the main problem in the watershed. The recommended plan provides grade stabilization for 22 more problem areas than the NED Plan, which results in an additional 7,900 acres of highly erodible cropland being adequately treated.

In addition tp providing grade control, the grade stabilization dams and structures are the most viable means to significantly affect

pollutants attached to and transported by soil particles. These grade stabilization dams and structures act as efficient traps for pollutants including sediment, phosphorus, nutrients, and pesticides.

The grade stabilization dams and structures will trap 95 percent of the sediment, 85 percent of the phosphorus, and similar amounts of other attached or adsorbed materials. These measures will be somewhat less effective in trapping highly mobile pollutants such as atrazine and nitrates. The recommended plan will provide 10,700 more acres of pollutant control than the NED plan. The recomended plan provides a greater degree of control and will significantly reduce pollutant loading and grade instability problems in the watershed.

The recommended plan addresses 22 identified problem areas that are not treated by the NED plan. Without P.L. 566 assistance the problem areas left untreated by the NED plan will not be treated with any other program. The recommended plan also proposes 16 grade stabilization structures instead of the 11 proposed by the NED plan. During the planning process the grade stabilization dams were deemed more desirable because (1) they will control the problem through the life of the project without major operation and maintenance costs to keep them functional, and (2) a smaller percentage of the cost will be borne by the local sector making local participation more possible. The NED plan, in comparison, was not considered desirable because of the lesser total benefits. For these reasons the sponsors are asking for an exception from the Secretary of Agriculture to select the recommended plan. Table T provides a summary of major differences between the NED plan and the recommended plan.

Table T - Comparison of the NED and Recommended Plans

	Ned Plan	Recommended Plan	Difference
Dams (No)	11	16	5
Land Treatment Structure Systems (No.)	25	42	17
Erosion Problem Areas Treated (No.)	36	58	22
Installation Cost ($)	5,299,900	8,584,700	3,284,800
Annualized OM&R Cost ($)	61,200	96,000	34,800
Dam & Structure Cost ($)	2,105,700	3,218,900	1,113,200
Annualized OM&R Cost ($)	3,300	5,000	1,700
Land Treatment Cost ($)	3,194,200	5,365,800	2,171,600
Annualized OM&R Cost ($)	57,900	91,000	33,100
Drainage Area Controlled (Ac.)	23,600	34,300	10,700
Road Crossings (No.)	69	99	30
Vehicles Per Day Fully Protected (V/Day)	2,900	3,700	800
Road and Bridge Maintenance Savings ($)	160,200	211,900	51,700
Bridge Construction Savings ($)	44,000	61,000	17,000
Cropland Benefitting From Gully Control (Ac.)	11,300	19,200	7,900
Cropland to be Terraced (Ac.)	5,800	9,800	4,000
Gross Erosion Savings (Tons/Yr.)	369,600	505,800	136,200
Off-Site Sediment Reduction (Tons/Yr.)	56,700	166,800	110,100
Gully Acres Prevented (Ac.)	580	1,100	520
Depreciated Acres Prevented (Ac.)	980	1,870	890
Area with Significant Pollution Control Impacts (Ac.)	23,600	34,300	10,700

RECOMMENDED PLAN

Purpose and Summary

The project is planned for the purposes of watershed protection and flood prevention. Major components of the flood prevention purpose are grade stabilization, erosion control, and floodwater damage reduction. The recommended plan includes 16 grade stabilization dams (reservoir type with floodwater storage) with required land treatment, land treatment structure systems at 42 erosion problem areas with required land treatment, accelerated land treatment, and forestland treatment.

For additional details about the recommended plan, see Tables 1, 2, 3, and 6 and the Project Map (Appendix D).

Plan Elements

Land Treatment Practices - The ongoing conservation program will provide adequate protection to 6,040 acres in the watershed with or without any project action. Accelerated land treatment will supplement the ongoing program on 1,890 acres of 3 to 6 percent sloping land. Required land treatment will be installed above grade stabilization dams and structures to meet program requirements and to insure the structures will function as planned. The land user's participation in each type of land treatment application is voluntary and the user will make the final decision on land use and practices to be installed.

Long-term contracts will be used to install project land treatment practices. Approximately 62 contracts averaging 160 acres each will be needed.

Land treatment structure systems will be installed at 42 erosion problem areas. These systems consist of small on-farm size structures with drainage areas generally 50 acres or less. These systems may include grade stabilization structures, diversions, and water and sediment control basins or combination of the three or only one of either.

Principal spillways for grade stabilization structures will be positioned to maintain specific water elevations to control gully grades and provide outlets for interdependent land treatment practices.

Land treatment practices to be installed in evaluation units 1, 2, and 3 include conservation tillage, contour farming, terraces, grass waterways, underground outlets, water and sediment control basins, diversions, and small grade stabilization structures. The project is formulated to protect the land resource base. Stable water outlets are a basic unit and are an integral part of all land treatment. Each problem area to be treated by this project has a

combination of terraced cropland and untreated cropland in two or more of the evaluation units 1, 2, and 3. Sometimes steep slopes (evaluation unit 3) are inclusions within a larger gentler slope group (evaluation unit 1). It will be practical to treat the whole area instead of just evaluation unit 1.

The accelerated program includes the following practices: conservation tillage, countour farming, terraces, grass waterways, underground outlets, water and sediment control basins, and small grade stabilization structures all within evaulation unit 1. In addition, this program includes hayland and pasture planting and critical area planting.

Table U - LAND TREATMENT - Ongoing, Required, and Accelerated

Type of Land Treatment	Location of Land Treatment	PL-566 b/ Tech Assist.	PL-566 b/ Financ. Assist.	Acres
Ongoing	Entire watershed a/	No	No	6,040
Required	Above grade stabilization dams	Yes	Yes	4,240
	Above land treatment structure systems	Yes	Yes	4,570
Accelerated	3-6 percent cropland erosion problem area	Yes	Yes	1,890

a/ See the project map for problem area locations. See Figure 1, example of land treatment type location.
b/ See Table 1 for assistance dollars

Land treatment practices to be installed in the project include:

Grade Stabilization Structure - Grade stabilization structures are constructed in drainageways that cannot be stabilized by terraces or other means. Structures stabilize grades and control erosion in channels, prevent formation or advance of gullies, enhance environmental quality and reduce pollution hazards. Most structures will be earthfill dams with corrugated metal pipe spillways. Sediment pools will temporarily contain water until it is replaced by sediment.

Water and Sediment Control Basins - Water and sediment control basins are short earth embankments or ridges and channels generally constructed across the slope and minor watercourses. They will all use underground outlets. They are used to reduce on-site erosion, reduce sediment content in water, intercept and conduct surface runoff through underground conduits to stable

outlets, reduce peak rate or volume of flow at downslope locations, reduce flooding, prevent gully development, reform the land surface, and improve farmability.

Conservation Tillage System - Conservation tillage is a form of tillage that does not plow under crop residue, but leaves large amounts of residue mulch on the soil surface throughout the year. Conservation tillage includes any tillage and planting system that maintains a residue on at least 30 percent of the soil surface after planting to reduce water and wind erosion. Conservation tillage is applied to terraced land and other cropland areas.

Grassed Waterway or Outlet - Grassed waterway or outlet is a natural or constructed waterway or outlet, shaped or graded, and established in suitable vegetation for the safe disposal of runoff. The grassed waterway will dispose of excess surface water from terraces, diversions, or natural concentrations without causing erosion or flooding.

Diversion - Diversion is a channel with a supporting ridge on the lower side constructed across the slope. It is designed to divert excess water from areas to sites where it can be used or disposed of safely.

Terrace - A terrace is an earth embankment or a combination ridge and channel constructed across the slope to intercept and conduct surface runoff at a nonerosive velocity to a stable outlet. The terrace is designed with a slight downward slope across the field to the outlet. A grass waterway or underground conduit is commonly used as the outlet.

Critical Area Planting - Critical area planting consists of planting grasses and legumes on highly erodible or critically eroding areas to stabilize the soil, reduce damage from sediment and runoff to downstream areas, and improve wildlife habitat and visual resources.

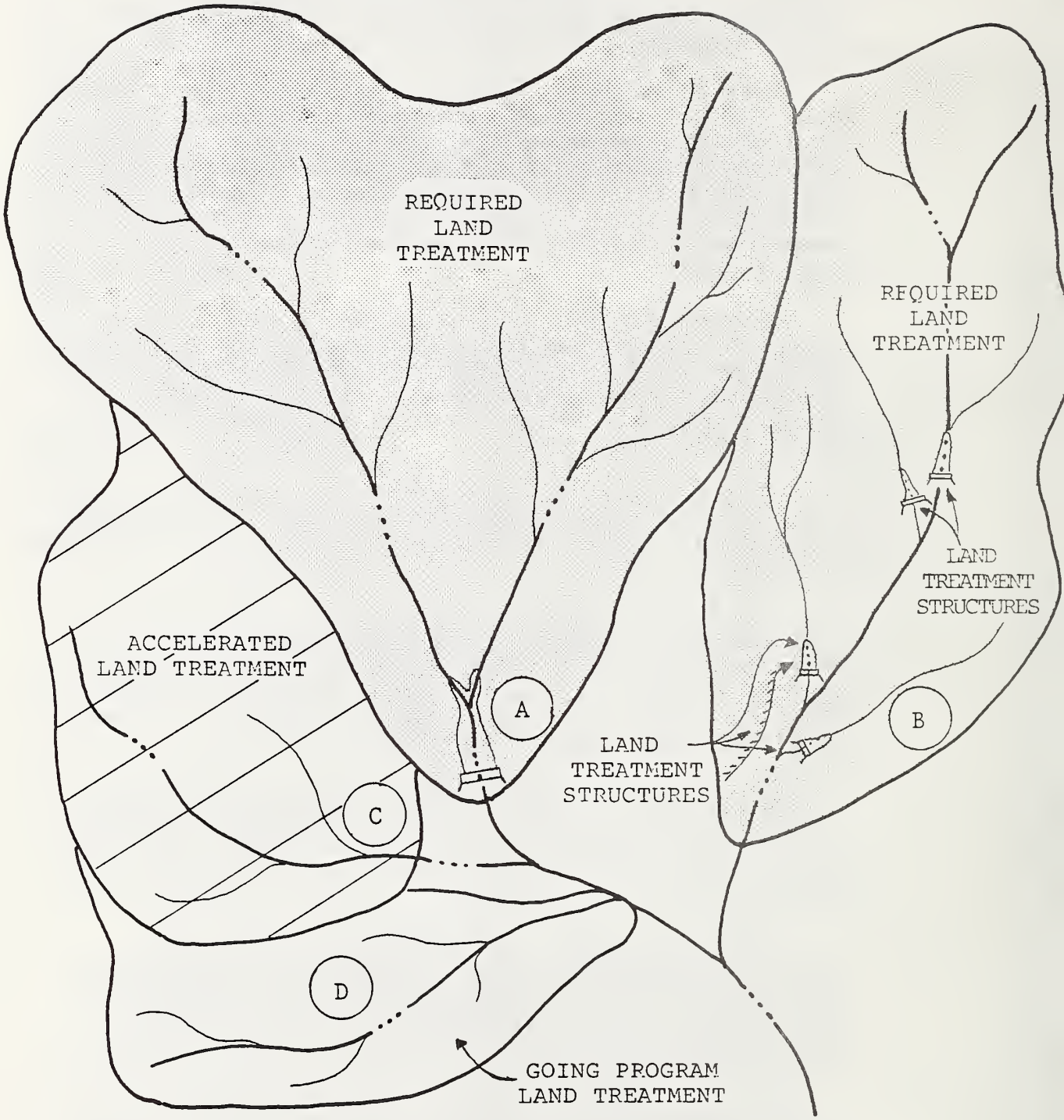
Underground Outlet - Underground outlet is a conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet. It is to dispose of excess water from terraces, diversions, subsurface drains, surface drains, or other concentrations without causing damage by erosion or flooding.

Pasture and Hayland Planting - Pasture and hayland planting is establishing and reestablishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants. The purpose of this practice is to reduce erosion, to produce high-quality forage, and to adjust land use.

A participation rate of approximately 90 percent is estimated for project land treatment practice implementation.

FIGURE 1

LAND TREATMENT TYPE EXAMPLE



A. Problem area treated with large grade stabilization dam and required land treatment

B. Problem area treated with land treatment structures and required land treatment

C. Area treated with accelerated land treatment

D. Area treated with going program land treatment

A Forestry Work Plan 4/ was developed for the watershed by the Kansas State and Extension Forester, cooperating with the USDA Forest Service. Forestry technical assistance will be provided through the watershed project and the Cooperative Forest Management Program. Forestland improvement will permit an increased annual harvest of high quality trees.

The watershed is protected by rural fire districts. Equipment procurement, training in fire fighting and control, and fire prevention education will be continued. Technical assistance for fire control measures will be provided by the Kansas State and Extension Forester through the Cooperative Fire Control Program.

Structural Measures - Sixteen (16) grade stabilization dams will be installed as structural measures to control gullies and reduce flooding. All structural measures will be earthfill dams. See Project Map (Appendix D) for structure locations.

Each grade stabilization dam will have a drop-inlet type principal spillway constructed to maintain water at a specific elevation to control a gully problem and to release floodwater from a detention pool. (A typical dam with a drop-inlet principal spillway is shown in Appendix B.)

Principal spillways will be of reinforced concrete pipe. Each spillway will have a single-stage uncontrolled inlet. Release rates will average about 40 cubic feet per second per square mile (csm) and will not exceed present downstream channel capacities. Stilling basins at spillway outlets will dissipate energy.

The dams will have vegetated emergency spillways to discharge runoff safely when reservoir and principal spillway capacities are exceeded. In any one year the chance of operation of the emergency spillway at any site is 4 percent or less. Emergency spillways of some structures will require topsoiling to establish and maintain vegetation.

The 16 dams will provide detention storage varying from 1.16 to 2.80 inches of runoff. Runoff from 16.66 square miles, 15 percent of the watershed, will be controlled. The combined volume of retarding storage will be 1,693 acre-feet (equivalent to 1.90 inches of runoff from the drainage area controlled) with a combined temporary surface area of 344 acres.

Structure 7-11 is planned to accommodate a roadway across the dam. Plans are to widen the top of the dam from 14 to 26 feet, lengthen the principal spillway, and to do the earthwork and shaping needed to pass the roadway through the emergency spillway. Items such as guardrails and roadway surfacing will be the sponsor's responsibility. Guardrails and other safety measure needs will be determined by the appropriate road authority.

Each principal spillway crest is designed to maintain water at the elevation necessary to stop the gully problem or to provide storage for a 50-year accumulation of sediment. Sediment storage capacity varies from 0.98 to 5.20 inches. Combined sediment storage volume for all structures will total 1,650 acre-feet. Combined surface area of the sediment pools will total 189 acres.

Borrow areas will be confined to sediment pools and emergency spillway excavations, where practical. Borrow areas will be left rough and uneven to enhance fish production, where practical. Borrow material at most dam sites will be CL and CH (Unified Soil Classification System).

Existing trees and brush may be left in pool areas for fishery enhancement where it is requested by sponsors. Maintenance costs may increase slightly by leaving trees and brush in sediment pool areas.

Most of the grade stabilization dams will be on deep till foundations in narrow valleys. Depth of soils in most abutments exceeds 20 feet.

The need for water and air pollution abatement during construction will be determined on a site-by-site basis. Abatement measures normally include dry stream crossings, temporary vegetative establishment, watering for dust control, controlled burning, and sediment control basins.

Mitigation Features

The project without mitigation would result in a loss of 320 habitat units of forestland and 640 habitat units of herbaceous habitat. Tables VII, VIII, and IX, Appendix C, show the acreages of land, by dam site and by land treatment type, that sponsors will provide for compensation of wildlife habitat losses. Compensation measures will be located in the general vicinity of each site; however, actual locations will be determined during land rights acquisition. Landowners who desire wildlife areas will be given first consideration. Wildlife habitat compensation measures include establishment and management of native grasses and forbs on 66 acres, woody plantings on 43 acres, or woodland preservation and management on 86 acres. A combination of woody planting and preservation may be used.

Projected habitat losses and compensation will be reviewed in detail during the group land treatment planning process for each problem area. Significant changes from projected amounts will result in modification of the type and extent of compensation.

Cultural Resources

Personnel involved in project installation will be alerted to watch for cultural resources (buildings, structures or artifact type materials that may contain information important to history or prehistory) during construction. If cultural resources are found, SCS procedures for their protection will be followed.

Permits and Compliance

A permit to construct is required by the State of Kansas for each structural measure in the project. No federal 404 (Section 404 of P.L. 92-500) permits are required for any project measure as all are located on streams having average flow of less than 5 cfs.

Dam Safety

In the event of failure, damage to the area downstream of a class "a" dam would be limited to farm buildings, agricultural land, or township and county roads. A greater hazard potential could be created if additional development occurs in the breach inundation area of any dam. The hazard classification would then become either class "b" or class "c". For class "b" dams, damage would be limited to isolated homes, main highways, minor railroads, or interruption of service of relatively important public utilities. And for class "c" dams, loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads could occur.

Class "a" dams are planned to have the least amount of floodwater retarding storage, class "b" dams contain intermediate storage, and class "c" dams the greatest amount of storage. Having less storage, class "a" dams have the greatest potential to be overtopped by extreme floods. Class "c" dams are planned to safely pass the maximum probable flood without overtopping but could fail from other causes, and would pose greater danger in case of failure. Other things being equal, failure of a dam with greater storage can cause more damage than one with lesser storage.

Overtopping is just one type of failure; any dam can fail for other reasons unless properly designed, constructed, operated, and maintained. Examples of the most common failures listed in the order most likely to occur, based on historical records (Engineering News Record, May 8, 1980) are: leakage, outlet works damage, slope instability, inadequate slope protection, overtopping, deterioration, and embankment deformation.

A breach analysis was made for each dam included in this plan to estimate the maximum area downstream that might be flooded if the dam should fail. Based on this, each dam has been assigned a hazard classification as shown in Table 3. SCS has classified all of the dams as class "a." Although some building symbols are shown in the flood plain, the elevations have been considered in breach inundation studies and are not affected. A site specific study should be made before developing or building anywhere in the flood plain (benefited area) shown in yellow on the Project Map (Appendix D).

Breach hazard information is available from SCS. The information will also be made available to local governments having control over development. The hazard classification will be reviewed prior to construction of each dam and reclassified, if necessary.

Costs

Total project cost is $8,584,700, of which $1,766,900 will be borne by local funds and $6,817,800 by P.L. 566 funds. The agreement shows actual cost-sharing between P.L. 566 and other funds. The P.L. 566 funds include $1,995,000 for dam construction and mitigation costs; $678,100 for engineering services; $319,100 for project administration; $1,307,800 for land treatment technical services, and $2,517,800 for land treatment construction. Local costs include $191,100 for land rights, $35,600 for project administration, $1,307,100 for land treatment construction, and $233,100 for land treatment technical services. All costs reflect a 1988 price base. Estimated costs are shown in Table 1.

Land treatment costs include all funds provided for technical and financial assistance to install the planned measures. Landowners and operators will pay the local share of the cost of land treatment measures.

Structural measure costs are also summarized in Table 1. These costs are shown by individual dam in Table 2.

Construction costs are direct costs for installation of structural measures. Construction includes such items as earth embankment, excavation, riprap, reinforced concrete, reinforced concrete pipe, wildlife habitat compensation measures, seeding, and fencing.

Engineering services costs for structural measures include all direct and related costs of surveys, geologic investigations, soil mechanics testing and analyses, designs, plans, and specifications.

Land rights costs are direct and related costs for the right to install, operate, and maintain works of improvement. These costs include land purchases, easements, agreements, permits, and modifications of properties and utilities. Land values were determined by the Wolf River Watershed board with SCS concurrence. Land rights cost estimates are based on current land values that vary from $240 per acre for woodland and miscellaneous land to $1,120 per acre for flood plain cropland. Land rights cost estimates may exceed actual expenses because some land rights may be donated. Land rights costs for about 270 acres are needed for the grade stabilization dams.

Relocation costs include all payments and services provided according to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. The sponsors and SCS expect that no relocations will occur. However, the Agreement contains provisions for sharing relocation costs should they occur.

Project administration costs include contract administration, review of engineering plans prepared by others, construction inspection, and relocation assistance advisory services.

The watershed district will pay for portions of Structure 7-11 to accommodate a roadway across the dam. The district will pay a percentage (see Agreement) of the construction and engineering costs for the structure. The costs are shown in Table 2 as nonproject costs. The SCS and the watershed district will enter into an agreement on payment of these costs prior to starting the work.

Cost sharing between P.L. 566 and other sources is shown in the Agreement.

Installation and Financing

Works of improvement will be installed in a 10-year period following authorization of federal assistance under P.L. 566. Table V shows anticipated cost by fiscal year for land treatment and structural measures:

Table V - Distribution of Project Costs by Fiscal Year
Land Treatment and Structural

Fiscal Year	P. L. 566	Other	Total
Land Treatment			
1	163,000	59,700	222,700
2	419,100	180,300	599,400
3	366,500	146,500	513,000
4	458,500	183,800	642,300
5	505,600	209,800	715,400
6	314,800	124,600	439,400
7	319,200	113,900	433,100
8	518,600	207,100	725,700
9	406,900	160,000	566,900
10	353,400	154,500	507,900
Subtotal	3,825,600	1,540,200	5,365,800
Structural			
1	43,900	30,500	74,400
2	249,500	19,800	269,300
3	182,900	11,400	194,300
4	234,800	29,900	264,700
5	379,400	20,600	400,000
6	365,600	12,100	377,700
7	305,900	25,400	331,300
8	383,800	36,100	419,900
9	403,300	10,700	414,000
10	443,100	30,200	473,300
Subtotal	2,992,200	226,700	3,218,900
Total Project	6,817,800	1,766,900	8,584,700

Wolf River Watershed Joint District No. 66 has the necessary authority to finance and install the planned project. This includes the right to accept contributions, levy taxes, make assessments against benefited land, issue bonds, and exercise the right of eminent domain. The watershed district has agreed to use these powers as needed. The watershed district will be financially responsible for excess investigation and design costs resulting from their failure to exercise or delay in exercising their rights under Kansas Statue 24-1218.

Expenses of organizing the watershed district have been paid and current general expenses are being met by an annual ad valorem tax. Future expenses of the sponsors will be paid from funds on hand, funds to be collected through taxes, or through the issuance of general obligation bonds.

P.L. 566 funds for construction of structural measures will be provided to the watershed district through project agreements with the SCS. A separate project agreement will be prepared for each construction contract.

Prior to making agreements that obligate funds of the SCS, the watershed district will develop a financial management system for control, accountability, and disclosure of P.L. 566 funds received, and for control and accountability for property and other assets purchased with P.L. 566 funds. The watershed district will be required to develop an acceptable code of conduct for its members. The watershed district will pay its own contract administration costs.

Federal technical assistance, engineering services, project administration, and funds for construction are contingent upon appropriations for these purposes.

The SCS, upon request, will provide technical assistance to the conservation districts for installation of land treatment. The conservation districts set priorities for SCS technical assistance. The watershed district has a field representative who contacts individual landowners and operators to urge them to cooperate in establishing conservation practices on their farms. The field representative's duties include informing people of the watershed program and its progress. Participation in programs to plan and install land treatment is voluntary, and landowners and operators will make final decisions on land use and practices to be installed.

The going program will be continued in the watershed as it would have been without project action. Table 1 shows the amount of P.L. 566 assistance for project land treatment. Actual amounts of technical and financial assistance provided by each program will vary from year to year depending upon availability of funds. The following criteria will also guide determination of program assistance:

1. The accelerated program will supplement the going program.

2. Technical and financial assistance cannot be used to implement measures cost shared under the going program.

3. Financial assistance is available for the following practices at the indicated maximum cost share:

Practice	Federal PL-566 Cost Share - %
Terraces	65
Grassed waterways	65
Grade stabilization structures	70
Underground outlet	65
Diversions	65
Water and sediment control basins	65
Pasture and Hayland Planting	65
Critical Area Planting	65
Forestland Improvement	No cost share

Three types of agreements can be used for cost sharing land treatment: (1) between SCS and the conservation districts; (2) between SCS and the conservation districts with a long-term agreement between the conservation districts and the landowner or operator; or (3) long-term agreement between SCS and the landowner or operator. Conservation plans will be made a part of each agreement.

Procurement methods can include construction contract, vegetative contract, small purchase agreement, force account, performance of work, and average cost. Agreements made by sponsors or individuals with SCS will describe the procurement method, installation arrangements, method of payment, and operation and maintenance requirements. Non cost-shared management practices will be required as a condition for cost-sharing when they are necessary to achieve project objectives.

Long-term agreements will be for at least 5 years and not more than 10 years. All structural cost-shared land treatment will be completed prior to the last two years of the agreement.

Installation costs of forestry land treatment will be borne by individual landowners, and other federal programs. The cost of accelerated technical forestry assistance will be borne by P.L. 566 through the Kansas State and Extension Forester cooperating with the U.S. Forest Service.

The SCS will provide technical assistance for application of wildlife measures. The Kansas Fish and Game Commission will also provide technical assistance as resources permit.

County Agricultural Stabilization and Conservation committees will cooperate with conservation districts to accelerate assistance for conservation practices. The Extension Service will assist with the educational phase of the land treatment program.

Administration will be shared by landowners, the watershed district, conservation districts, and SCS. Additionally, any agency offering an assistance program for land treatment will administer its own program.

Land treatment measures will be applied according to a schedule developed jointly for each county by the conservation districts and the watershed district. This schedule will meet the goals of the conservation districts and the watershed district and correlate with the grade stabilization dams installation schedule.

The problem areas selected for land treatment group planning will include logical construction units. Commitments will be obtained from the operators of not less than 75 percent of the land in that construction unit to carry out the planned land treatment measures before any long-term agreements are negociated within the planning unit.

A group plan will be developed with the landowner for installation of land treatment in the drainage area of each problem area with assistance from the District Conservationist, Conservation District and Watershed District Representatives.

This group meeting will be jointly conducted where appropriate by the Conservation District and the Watershed District.

The following items will be addressed by each district respectively:

Watershed District - Review purpose of the watershed program as it relates to the problem area. Explain the need for the watershed structure (grade stabilization dam), etc.
- Review land rights needs
- Review wildlife compensation land rights
- Review operation and maintenance needs of grade stabilization dam

Conservation District - Review land treatment needs and purpose of conservation plans (individuals and group)
- Schedule with individuals development of individual and/or update conservation plans
- Review wildlife planning needs for compensation
- Identify and/or plan joint conservation practices between two or more landowners
- Review operation and maintenance of conservation practices
- Review group agreement for the group plan

The linear feet of diversions, number of water and sediment control basins, and number of small grade stabilization structures to be installed at each erosion problem area will be determined through group planning and conservation planning with individual landusers. Technical installation assistance will be the responsibility of the local district conservationist. A field level environmental

assessment will be made and recommendations identified to mitigate losses in each group plan. See Table IX for typical losses and mitigation recommendations.

The watershed district and conservation districts with assistance from SCS will negotiate contracts for construction of terraces, grass waterways, diversions, water and sediment basins, and small grade stabilization dams. The district conservationist will provide design and layout assistance and necessary inspection.

The watershed district will develop, and keep current throughout project installation, a schedule of dam installation. The schedule will identify when each dam is to be installed with particular detail on the current year and following two years. Other dams may be grouped for installation in following years. This schedule will be used to guide land treatment installation and land rights acquisition.

The watershed district will employ a Contracting Officer and contract for construction of grade stabilization dams installed as structural measures. Construction contracts will be awarded on the basis of competitive sealed bidding. Contracting will begin when land rights have been obtained, P.L. 566 funds and technical assistance are available, approved drawings and specifications have been developed, and the necessary construction permits obtained. The SCS will furnish engineering services for the grade stabilization dams.

The watershed district will furnish legal services and obtain all land rights needed for installation of grade stabilization dams (structural measures). The watershed district will maintain a land rights schedule showing status of land rights for each site within the watershed. The watershed district will also make arrangements to abandon, move, or modify roads and utilities where necessary.

Operation, Maintenance, and Replacement

Operation is the administration, management, and performance of any services needed to insure proper functioning of the measure throughout its evaluated life. This includes such items as periodic inspections, reports, and/or other needed labor, etc.

Maintenance can be divided into either annual or periodic maintenance of project measures. Annual maintenance is the regular service required on the measure to prevent deterioration and insure the consistent functioning. It includes controlling growth of undesirable vegetation; management of grass cover such as mowing, controlled grazing, and fertilization; cleaning trash racks, etc.

Periodic maintenance is required on a recurring basis but less often than annually. Periodic maintenance includes spot revegetation, fence repair, and the more complex and costly work required to repair concrete, steel, or earthen parts of measures. Damages to completed measures caused by normal deterioration, drought, flooding caused by rainfall in excess of design rainfall, or vandalism is considered

maintenance regardless of whether it occurs immediately or several years after a measure is installed or established.

Replacement is required when a component has a shorter life span than the measure evaluation period and must be replaced with a new item to insure continued effectiveness of the measure. Replacement could also be required when a major storm causes such severe damage the component can no longer function properly. Replacement includes significant erosion repair, repair of emergency spillways, replacement of principal spillway pipe conduits, etc.

Land treatment measures will be maintained by owners and operators of farms on which the measures are installed. Agreements for cost sharing will spell out operation and maintenance requirements and responsibilities for each measure. Conservation district representatives will periodically inspect land treatment measures and will encourage landowners to perform needed maintenance, to replace obsolete measures, and to help plan and install new measures necessary to maintain adequate protection.

Agreements between Wolf River Watershed District, conservation districts, and the landowners will be made for maintenance and replacement of land treatment structure systems. These agreements will include schedules to periodically inspect structure systems and specify needed repairs. Annual maintenance will be the responsibility of benefiting landowners. Replacement costs will be cost shared by the watershed district, conservation district, and benefiting landowners.

Technical assistance to landowners for operating and maintaining forestland improvement measures will be provided by the Kansas State and Extension Forester in cooperation with the Forest Service.

An agreement calling for the watershed district to operate and maintain each grade stabilization dam and its related wildlife habitat and other vegetative measures will be made with SCS before construction of the dam begins. A plan of operation and maintenance will be developed for each dam 19/ including provisions for retention, use, and disposal of property acquired or improved with P.L. 566 assistance. The SCS will provide technical assistance.

Operation and maintenance of dams and wildlife areas will be in accordance with the vegetative management plan to be developed by sponsors and landowners with SCS assistance at the time land rights are acquired.

Estimated annualized average annual operation and maintenance cost for the grade stabilization dams is $5,000. Estimated average annual operation and maintenance cost for land treatment measures is $91,000.

Wolf River Watershed Joint District No. 66 will be responsible for maintaining drawdown control valves and passing natural streamflow

through all P.L. 566 grade stabilization dams to meet downstream water rights as provided by the Kansas Water Appropriation Act. The watershed district will open drawdown control valves as necessary for pool drainage for operation and maintenance.

Each dam will be jointly inspected by SCS and the sponsors immediately after initial filling and annually thereafter by the sponsors. The inspection team is to: review hazard classification, assess O&M adequacy, identify unsafe conditions, and specify work needed. A qualified engineer will assist during or immediately following the occurrence of major events such as floods or earthquakes, and with annual inspections for the first three years. Formal inspections are to be conducted under the leadership of a qualified engineer at least once every five years for class (b) and (c) dams (see Table 3).

Items of inspection will be listed in the Plan of Operation and Maintenance and will include, but not be limited to, the principal spillway and its appurtenances, emergency spillway, dam, vegetation on the dam and emergency spillway, fences installed as part of the project, and wildlife habitat measures. Records of inspection will be kept by the watershed district. The watershed district will be responsible for access to conduct the inspections.

Access to the grade stabilization dams will be controlled by landowners except as necessary for inspection, operation, and maintenance. The watershed district will notify landowners and the Kansas Department of Health and Environment of the need for sanitary facilities if significant recreational use occurs. If significant recreational use occurs, water quality monitoring may be required during the swimming season. The Kansas Department of Health and Environment will provide technical assistance to control disease-producing organisms.

TABLE 1 - ESTIMATED INSTALLATION COST

Squaw Creek Lower Wolf Watershed, Kansas

Installation Cost Item	Unit	Total	Estimated Cost (Dollars) a/						Total
			P.L. 566 Funds			Other Funds			
			SCS b/	FS b/	Total	SCS b/	FS b/	Total	
LAND TREATMENT									
STRUCTURE SYSTEMS									
Grade Stabilization Struc. (EU 1,2,3) c/	No.	132	711,300		711,300	304,800		304,800	1,016,100
Water & Sediment Control Basins (EU 1,2,3)	No.	67	57,600		57,600	31,000		31,000	88,600
Diversions (EU 1,2,3)	Mi.	16.3	263,400		263,400	141,900		141,900	405,300
Grassed Waterways (EU 1 only)	Ac.	61	28,000		28,000	15,000		15,000	43,000
Technical Assistance			528,000		528,000	93,200		93,200	621,200
SUBTOTAL			1,588,300		1,588,300	585,900		585,900	2,174,200
REQUIRED ABOVE LAND TREATMENT									
STRUCTURE SYSTEMS									
Evaluation Unit 1 (Terraces)	Ac.	2,291	133,000		133,000	71,600		71,600	204,600
" " 2 "	Ac.	1,152	217,600		217,600	117,100		117,100	334,700
3 "	Ac.	1,123	247,600		247,600	133,400		133,400	381,000
Technical Assistance			312,900		312,900	55,200		55,200	368,100
SUBTOTAL			911,100		911,100	377,300		377,300	1,288,400
REQUIRED ABOVE STRUCTURAL MEASURES									
Evaluation Unit 1 (Terraces)	Ac.	2,604	151,100		151,100	81,400		81,400	232,500
" " 2 "	Ac.	963	181,900		181,900	97,900		97,900	279,800
" " 3 "	Ac.	677	149,300		149,300	80,400		80,400	229,700
Grade Stabilization Structures (EU 1,2,3)	No.	2	7,700		7,700	3,300		3,300	11,000
Grassed Waterways (EU 1 only)	Ac.	70	32,100		32,100	17,300		17,300	49,400
Technical Assistance			272,800		272,800	48,200		48,200	321,000
SUBTOTAL			794,900		794,900	328,500		328,500	1,123,400
ACCELERATED									
Pasture and Hayland Planting (EU 2 & 3)	Ac.	700	34,300		34,300	18,400		18,400	52,700
Critical Area Planting (EU 3)	Ac.	131	13,700		13,700	7,400		7,400	21,100
Evaluation Unit 1 (Terraces)	Ac.	1,062	61,600		61,600	33,200		33,200	94,800
Grade Stabilization Structures (EU 1)	No.	27	147,600		147,600	63,300		63,300	210,900
Diversions (EU 1)	Mi.	3.64	54,700		54,700	29,500		29,500	84,200
Water & Sediment Control Basins (EU 1)	No.	15	12,000		12,000	6,400		6,400	18,400
Grassed Waterways (EU 1 only)	Ac.	29	13,300		13,300	7,200		7,200	20,500
Technical Assistance			163,300		163,300	28,800		28,800	192,100
SUBTOTAL			500,500		500,500	194,200		194,200	694,700
Forestry	Ac.	2,660					46,600	46,600	46,600
Technical Assistance				30,800	30,800		7,700	7,700	38,500
SUBTOTAL				30,800	30,800		54,300	54,300	85,100
TOTAL LAND TREATMENT			3,794,800	30,800	3,825,600	1,485,900	54,300	1,540,200	5,365,800
STRUCTURAL MEASURES	No.	16	2,992,200		2,992,200	226,700		226,700	3,218,900
TOTAL PROJECT			6,787,000	30,800	6,817,800	1,712,600	54,300	1,766,900	8,584,700

a/ Price Base 1988
b/ Federal agency responsible for assistance in installation of works of improvement
c/ EU - Evaluation Unit

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TABLE 2 - ESTIMATED COST DISTRIBUTION
Grade Stabilization Dams

Squaw Creek Lower Wolf Watershed, Kansas

(Dollars) a/

Item	Installation Cost - P. L. 566 Funds				Installation Cost - Other Funds					Total Installation Cost
	Construction	Engineering	Project Adm.	Total P. L. 566	Construction	Engr.	Land Rights	Project Adm.	Total Other	
2-11	88,700	30,100	14,200	133,000			3,400	1,700	5,100	138,100
2-15A	124,900	42,500	19,900	187,300			9,900	2,200	12,100	199,400
3-4A	137,300	46,600	22,000	205,900			19,100	2,500	21,600	227,500
5-1B	261,700	91,600	47,800	401,100			29,300	3,100	32,400	433,500
5-3	130,700	44,500	20,900	196,100			8,100	2,300	10,400	206,500
5-8	156,900	53,300	25,100	235,300			14,500	2,800	17,300	252,600
5-9	82,400	27,300	14,300	124,000			6,500 b/	1,600	8,100	132,100
5-15	83,200	27,700	15,900	126,800			9,000	1,700	10,700	137,500
5-16	85,800	28,500	17,100	131,400			10,800 c/	1,900	12,700	144,100
6-4A	76,500	25,300	16,900	118,700			15,600	1,900	17,500	136,200
6-5A	180,100	61,200	28,900	270,200			21,800	3,200	25,000	295,200
6-12A	122,000	41,700	19,600	183,300			8,000 d/	2,200	10,200	193,500
6-13A	116,900	39,700	18,700	175,300			17,600	2,200	19,800	195,100
7-3	68,400	23,000	11,000	102,400			4,000	1,300	5,300	107,700
7-11	177,900	60,500	10,500	248,900	(14,300) e/	(4,800) e/	8,300	3,200	11,500	206,400
8-7	101,600	34,600	16,300	152,500			5,200 f/	1,800	7,000	159,500
TOTAL	1,995,000	678,100	319,100	2,992,200	0	0	191,100	35,600	226,700	3,218,900

a/ Price Base 1988
b/ Includes $400 for farmstead dike
c/ Includes $200 for farmstead dike
d/ Includes $500 for farmstead dike and $200 for road modification
e/ Non-project cost for road fill dam
f/ Includes $700 for pipeline modification

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TABLE 3 - STRUCTURAL DATA
GRADE STABILIZATION STRUCTURES

Squaw Creek Lower Wolf Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER					
		2-11	2-15A	3-4A	5-1B	5-3	5-8
Class of Structure		a	a	a	a	a	a
Drainage Area (Total)	Sq. Mi.	0.29	0.63	0.68	1.78	0.47	1.20
Controlled by Upstr. Structure(s)	Sq. Mi.	-	-	-	-	-	-
Curve No. (1 day)(AMC II)		71	72	73	72	72	73
Time of Concentration (Tc)	Hours	0.2	0.5	0.4	0.9	0.4	0.7
Elevation Top of Dam	Ft.(msl)	945.9	987.0	1,042.5	965.4	972.8	980.2
Elevation Crest Emergency Spillway	Ft.(msl)	940.9	982.0	1,037.5	960.4	967.8	975.2
Elevation Crest Inlet	Ft.(msl)	936.2	976.7	1,031.7	953.0	962.4	965.5
Maximum Height of Dam	Ft.	39	37	40	37	43	38
Volume of Fill	Cu. Yds.	25,200	42,800	49,500	90,400	48,200	67,800
Total Capacity[a/]	Ac. Ft.	108	186	215	452	132	310
Sediment Submerged	Ac. Ft.	72	109	116	218	74	120
Sediment Aerated	Ac. Ft.	8	12	12	24	8	14
Retarding	Ac. Ft.	28	65	87	210	50	176
Surface Area							
Sediment Pool	Acres	5	11	14	27	8	14
Retarding Pool[a/]	Acres	7	17	20	43	12	27
Principal Spillway Design							
Rainfall Volume (1 day)	Inches	5.90	5.90	6.60	5.90	5.90	5.90
Rainfall Volume (10 day)	Inches	10.00	10.00	11.30	10.00	10.10	10.00
Runoff Volume (10 day)	Inches	4.00	4.15	5.33	4.20	4.22	4.31
Capacity (Max.)	c.f.s.	34	35	36	37	36	34
Frequency Operation-Emer. Splwy.	% Chance	4	4	2	4	4	4
Conduit Diameter	Inches	18	18	18	18	18	18
Emergency Spillway Design							
Rainfall Volume	Inches	5.60	5.60	8.17	5.60	5.60	5.60
Runoff Volume	Inches	2.60	2.67	4.96	2.70	2.70	2.76
Storm Duration	Hours	6	6	6	6	6	6
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	40	40	60	40	40	40
Velocity of Flow (Ve)	Ft./Sec.	1.4	2.7	5.5	3.3	2.0	-
Slope of Exit Channel	Ft./Ft.	.04	.04	.04	.04	.04	.04
Max. Reservoir Water Surface Elev.	Ft.(msl)	941.1	982.7	1,039.3	961.2	968.2	975.2
Freeboard Design							
Rainfall Volume	Inches	8.17	8.17	14.16	8.17	8.17	8.17
Runoff Volume	Inches	4.73	4.84	10.53	4.84	4.84	4.96
Storm Duration	Hours	6	6	6	6	6	6
Max. Reservoir Water Surface Elev.	Ft.(msl)	942.5	984.0	1,041.5	963.4	969.7	977.8
Capacity Equivalents							
Sediment Volume	Inches	5.20	3.61	3.54	2.55	3.26	2.09
Retarding Volume	Inches	1.80	1.94	2.40	2.21	1.99	2.75

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TABLE 3 - STRUCTURAL DATA
GRADE STABILIZATION STRUCTURES

Squaw Creek Lower Wolf Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER					
		5-9	5-15	5-16	6-4A	6-5A	6-12A
Class of Structure		a	a	a	a	a	a
Drainage Area (Total)	Sq. Mi.	0.39	0.42	0.52	0.83	3.20	1.13
Controlled by Upstr. Structure(s)	Sq. Mi.	-	-	-	-	0.83	-
Curve No. (1 day)(AMC II)		73	73	73	73	73	72
Time of Concentration (Tc)	Hours	0.3	0.3	0.3	0.7	0.5	0.4
Elevation Top of Dam	Ft.(msl)	1,023.3	1,068.3	1,081.9	1,066.9	987.3	1,010.1
Elevation Crest Emergency Spillway	Ft.(msl)	1,018.3	1,063.3	1,076.9	1,061.9	982.3	1,005.1
Elevation Crest Inlet	Ft.(msl)	1,014.2	1,058.2	1,071.8	1,053.5	975.4	997.7
Maximum Height of Dam	Ft.	32	33	35	36	37	33
Volume of Fill	Cu. Yds	34,900	38,000	41,700	49,000	57,700	31,900
Total Capacity[a/]	Ac. Ft.	90	122	143	189	352	152
Sediment Submerged	Ac. Ft.	49	57	59	58	139	67
Sediment Aerated	Ac. Ft.	6	6	6	7	16	8
Retarding	Ac. Ft.	35	59	78	124	197	77
Surface Area							
Sediment Pool	Acres	7	8	9	9	21	8
Retarding Pool[a/]	Acres	10	15	19	22	40	15
Principal Spillway Design							
Rainfall Volume (1 day)	Inches	4.50[b/]	6.65	6.65	6.65	6.65	6.65
Rainfall Volume (10 day)	Inches	[c/]	11.30	11.30	11.30	11.30	11.30
Runoff Volume (10 day)	Inches	1.90[b/]	5.33	5.33	5.33	5.33	5.10
Capacity (Max.)	c.f.s.	20	31	32	33	114	63
Frequency Operation-Emer. Splwy.	% Chance	4	2	2	2	2	2
Conduit Diameter	Inches	18	18	18	18	30	24
Emergency Spillway Design							
Rainfall Volume	Inches	5.00[d/]	8.17	8.17	8.17	8.17	8.17
Runoff Volume	Inches	3.70	4.96	4.96	4.96	4.96	4.86
Storm Duration	Hours	6	6	6	6	6	6
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Feet	40	40	40	80	200	150
Velocity of Flow (Ve)	Ft./Sec.	[e/]	4.6	4.1	5.1	4.8	4.7
Slope of Exit Channel	Ft./Ft.	.04	.04	.04	.04	.04	.04
Max. Reservoir Water Surface Elev.	Ft.(msl)	1,022.0[e/]	1,064.8	1,078.1	1,063.7	984.0	1,006.6
Freeboard Design							
Rainfall Volume	Inches	[e/]	14.16	14.16	14.16	14.16	14.16
Runoff Volume	Inches	[e/]	10.53	10.53	10.53	10.53	10.36
Storm Duration	Hours	[e/]	6	6	6	6	6
Max. Reservoir Water Surface Elev.	Ft.(msl)	1,023.0[f/]	1,066.7	1,080.0	1,065.9	986.3	1,008.5
Capacity Equivalents							
Sediment Volume	Inches	2.63	2.80	2.35	1.46	1.23	1.25
Retarding Volume	Inches	1.67	2.62	2.79	2.80	1.56	1.28

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TABLE 3 - STRUCTURAL DATA
GRADE STABILIZATION STRUCTURES

Squaw Creek Lower Wolf Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER				TOTAL
		6-13A	7-3	7-11	8-7	
Class of Structure		a	a	a	a	xxx
Drainage Area (Total)	Sq. Mi.	1.33	0.28	3.14	0.37	16.66[g]
Controlled by Upstr. Structure(s)	Sq. Mi.	-	-	-	-	.83
Curve No. (1 day)(AMC II)		72	77	76	68	xxx
Time of Concentration (Tc)	Hours	0.6	0.2	0.8	0.3	xxx
Elevation Top of Dam	Ft.(msl)	1,009.6	1,052.4	1,050.3	962.8	xxx
Elevation Crest Emergency Spillway	Ft.(msl)	1,004.6	1,047.4	1,044.3	957.8	xxx
Elevation Crest Inlet	Ft.(msl)	996.5	1,041.2	1,035.8	953.6	xxx
Maximum Height of Dam	Ft.	37	33	37	31	xxx
Volume of Fill	Cu. Yds.	42,900	22,000	74,100	36,400	752,500
Total Capacity[a]	Ac. Ft.	292	51	460	89	3,343
Sediment Submerged	Ac. Ft.	119	21	148	60	1,486
Sediment Aerated	Ac. Ft.	13	2	16	6	164
Retarding	Ac. Ft.	160	28	296	23	1,693
Surface Area						
Sediment Pool	Acres	14	3	24	7	189
Retarding Pool[a]	Acres	29	7	50	11	344
Principal Spillway Design						
Rainfall Volume (1 day)	Inches	5.90	4.40[b]	6.62	4.40[b]	xxx
Rainfall Volume (10 day)	Inches	9.90	c/	11.20	c/	xxx
Runoff Volume (10 day)	Inches	4.07	1.70[b]	5.80	1.40[b]	xxx
Capacity (Max.)	c.f.s.	34	22	112	21	xxx
Frequency Operation-Emer. Splwy.	% Chance	4	4	2	4	xxx
Conduit Diameter	Inches	18	18	30	18	xxx
Emergency Spillway Design						
Rainfall Volume	Inches	5.60	5.00[d]	8.17	5.00[d]	xxx
Runoff Volume	Inches	2.67	3.80	5.31	3.30	xxx
Storm Duration	Hours	6	6	6	6	xxx
Type		Veg.	Veg.	Veg.	Veg.	xxx
Bottom Width	Ft.	40	40	80	40	xxx
Velocity of Flow (Ve)	Ft./Sec.	2.5	e/	6.7	e/	xxx
Slope of Exit Channel	Ft./Ft.	.04	.04	.04	.04	xxx
Max. Reservoir Water Surface Elev.	Ft.(msl)	1,005.2	1,051.0[e]	1,047.0	961.8[e]	xxx
Freeboard Design						
Rainfall Volume	Inches	8.17	e/	14.16	e/	xxx
Runoff Volume	Inches	4.84	e/	10.97	e/	xxx
Storm Duration	Hours	6	e/	6	e/	xxx
Max. Reservoir Water Surface Elev.	Ft.(msl)	1,007.5	1,052.0[f]	1,050.3	962.8[f]	xxx
Capacity Equivalents						
Sediment Volume	Inches	1.86	1.55	0.98	3.40	xxx
Retarding Volume	Inches	2.26	1.90	1.77	1.16	xxx

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TABLE 3 - STRUCTURAL DATA
GRADE STABILIZATION STRUCTURES

Squaw Creek Lower Wolf Watershed, Kansas

a/ At crest of emergency spillway

b/ 25 year - 24 hour

c/ Not applicable to this structure because product of storage times height is less than 3,000

d/ 50 year - 24 hour

e/ Non-floodrouted

f/ Emergency spillway design plus 1.0 foot

g/ Includes .83 square mile controlled by upstream structures. Net drainage area controlled by structures is 15.83 square miles

TABLE 4 - ANNUALIZED ADVERSE RECOMMENDED PLAN EFFECTS

Squaw Creek Lower Wolf Watershed, Kansas

(Dollars) a/ b/

Evaluation Unit	Project Outlays ($)		Total
	Amortization of Installation Cost	Operation, Replacement, and Maintenance Cost	
Land Treatment - Accelerated	48,600	12,500	61,100
Land Treatment Structure Systems and Required Land Treatment	182,000	46,800	228,800
Grade Stabilization Dams and Required Land Treatment	230,600	35,000	265,600
Forestry Land Treatment	5,800	1,700	7,500
TOTAL	467,000	96,000	563,000

a/ Price base 1988 - All costs discounted and annualized at 8 5/8 percent interest rate for 60 years

b/ Costs for technical assistance to install associated measures and financially assisted accelerated land treatment in this evaluation unit are included.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL
FLOOD DAMAGE REDUCTION BENEFITS

Squaw Creek Lower Wolf Watershed, Kansas

(Dollars)[a/]

Item	Estimated Average Annual Damage		Damage Reduction Benefits [b/]	Annualized Damage Reduction Benefits
	Without Project	With Project		
Floodwater				
Crop and Pasture	217,100	206,100	11,000	7,100
Other Agricultural	31,200	29,800	1,400	900
Nonagricultural				
Road	8,500	7,400	1,100	700
Railroad	19,600	18,400	1,200	800
Urban	2,300	2,000	300	200
Bridge Construction	126,100	31,800	94,300	61,000
Subtotal	404,800	295,500	109,300	70,700
Sediment				
Channel Deposition	52,900	50,900	2,000	1,300
Road Ditches	60,000	7,600	52,400	33,900
Subtotal	112,900	58,500	54,400	35,200
Erosion				
Flood Plain Scour	20,600	20,200	400	300
Streambank/Upstream and Crossings	314,700	39,400	275,300	178,000
Gullies	644,900	270,900	374,000	241,700
Subtotal	980,200	330,500	649,700	420,000
GRAND TOTAL	1,497,900	684,500	813,400	525,900

a/ Price base 1988
b/ Includes effects of required land treatment measures

TABLE 6 - COMPARISON OF RECOMMENDED PLAN BENEFITS AND COSTS

Squaw Creek Lower Wolf Watershed, Kansas

(Dollars) a/

Evaluation Unit	Damage Reduction Benefits	Intensification Benefits			Total Benefits	Total Costs b/	Benefit: Cost Ratio
		Erosion	Flood Prevention	Timber Production			
Land Treatment - Accelerated	73,900	9,400	300	-	83,600	61,100	1.4:1
Land Treatment Structure Systems and Required Land Treatment	240,200	30,700	800	--	271,700	228,800	1.2:1
Grade Stabilization Dams and Required Land Treatment	211,800	27,100	700	--	239,600	265,600	0.9:1
Forestry Land Treatment	--	--	--	13,500	13,500	7,500	1.8:1
TOTAL	525,900	67,200	1,800	13,500	608,400	563,000	1.1:1

a/ Price base 1988. All benefits discounted to the beginning of the installation period and annualized at 8 5/8 percent interest rate for the period of analysis.
b/ From Table 4

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EFFECTS OF RECOMMENDED PLAN

A review of Table I shows that the recommended plan will have a major impact on flooding, grade stability (gullies), erosion, road crossings (bridge construction), agricultural income, sedimentation, and water quality. It will have a moderate impact on streamflow, land use, prime farmland, and wildlife. The recommended plan will also have minor impacts on mineral resources, fish, visual resources, air quality, wild fires, and recreation; however, these factors were of little significance to decision making. The project will have no impact on stream classification, groundwater, irrigation, wetlands, cultural resources, endangered or threatened plants and animals, minority populations, or relocation of people and farm operations. Rationale for not discussing a factor in this section was given in the Significant to Decision Making section. Monetary values of benefits and costs are included in Tables 5 and 6. Impacts are also shown in Table A.

Grade Stabilization (Gullies) and Related Impacts

Installation of the recommended grade stabilization dams and required land treatment will reduce problems discussed on pages 11 and 29 to the following extent:

Sheet and rill erosion will be reduced by 174,200 tons per year by treating 10,700 acres. About 3,100 acres of 5 percent slope land will have a projected soil loss of 2.1 tons per acre; the 7 percent slope group (4,810 acres) will have a projected soil loss of 2.5 tons per year; soils with slope greater than 10 percent (2,790 acres) will have a projected soil loss of 7.2 tons per year.

Ephemeral erosion on 10,700 acres of cropland will be essentially stopped by installation of terraces, contour farming, critical area planting, pasture and hayland planting, and conservation tillage. Erosion will be reduced from 75,200 to 24,900 tons per year, a net reduction of 50,300 tons per year.

The project will stop advancing gullies at 58 locations. This will result in a reduction of 1,100 acres of new gullies. About 9,400 acres of terraced cropland will be protected and 9,870 acres of untreated cropland will have stable water outlets so that terraces can be installed. This project action will reduce gully erosion from 335,000 to 186,700; a reduction of 148,300 tons per year.

Treatment of the projected gully area will allow 2,970 acres to remain as cropland that otherwise would revert to grass and trees.

Culverts and bridges will last much longer and road maintenance will be significantly reduced for approximately 102 road crossings. The project will allow full use of the transportation system serving 8,000 vehicles per day.

Prime farmland will be increased by 260 acres. Scour damages will be reduced on 290 acres.

Water quality will improve because of less cropland and gully erosion and sediment deposition in dams and land treatment structural systems. Each dam and spillway will be fenced and managed for wildlife.

The application of land treatment practices will protect lands from excessive sheet and rill, ephemeral, and gully erosion. This will help maintain yields, reduce production costs and improve the efficiency of the operator thus realizing a more dependable income for the area.

One grade stabilization dam is to be located on an existing roadway. Road maintenance costs due to advancing gullies will be greatly reduced at this location.

Erosion and Sedimentation Related Impacts

Decreased sediment load, if the only parameter affected, would increase the potential to erode stream channels. However, peak discharges and average flow velocities will also be reduced. A channel stability analysis indicates degradation may occur a few hundred feet below the grade stabilization dams after construction because of the reduction in suspended sediment availability. This degradation will continue for a short period until the channel slopes reach stable values for the new conditions. Redistribution of bedload supply and channel slope flattening will prevent excessive channel degradation.

A computer model was developed to determine bedload transport. This model was based on sediment yield using Schoklitsch's equation. Three reaches were modeled. The results showed a relatively stable stream channel condition with some degradation with large storms both with and without project but less with project and some aggradation with annual storms.

Flood damage reduction benefits from reduced sediment deposition are about 0.2 percent of the total benefits.

The trapping of sediments, other solids, and adsorbed chemicals in the impoundments created by this project will significantly reduce the amounts of these substances in downstream waters. The effect of storm-flow concentrations of nutrients, bacteria, sediment, and suspended solids will be reduced. The application of land treatment measures on 10,700 acres will reduce erosion which will further reduce the transport of sediment, nutrients, and pesticides. Generally, there will be a decrease in BOD and bacteria levels. Stream temperatures will not change significantly.

The completed project will reduce sediment yield to 94 miles of perennial stream by 44 percent thereby improving water quality as the

end result. Reduced sediment loads due to the project will improve fish habitat quality.

The project will reduce flood plain scour and improve the productive capability of 420 acres. Benefits from reduced flood plain scour damages are less than 0.1 percent of the total benefits.

Flooding and Streamflow Related Impacts

Installation of the project will cause less variation in streamflow. The structures will reduce high-flow peaks while prolonging discharge after storms. Some water will evaporate from impoundments. Seepage and prolonged discharge from reservoirs will contribute to stream base flows. Overall, the discharge and frequency of low flows is expected to increase. Streams will be dry less often although changes of stream classification are not expected. 33/

The 16 grade stabilization dams with flood control will reduce frequency, discharge, depth, area, and velocity of flood flows. Table W shows reduction of peak discharges and frequency of flooding with and without the project.

Table W - Peak Reductions and Bank Full Frequencies

Reach	Location	Percent a/ Peak Reduction	Bank full frequency w/o Project Times(s)/ Year(s)	Bank full frequency w/Project Time(s)/ Year(s)
1	Watershed outlet	20	1/4	1/7
2	Sec. 21-2-20E	20	2/7	1/6
4	Sec. 4-3-20E	23	1/3	2/9
5	North side Sec. 18-3-20E	24	1/3	1/5
6	Sec. 23-3-19E, north of Severance	25	1/11	1/27
8	Sec. 18-3-19E, Brown County line	28	3/4	1/2

a/ Average reductions for storms ranging from 4 inches to 10 inches of rainfall in 24 hours.

The recommended plan will accomplish a 6 percent reduction in average annual flood damage on 6,970 acres. Flood plain benefited in each reach and the percentage of damage reduction by structural measures is shown in Table X. Benefits from reduced crop and pasture flood damages are 1.1 percent of the total benefits.

Table X - Flood Damage Reduction

Evaluation Reach	Flood Plain a/ Benefited (acres)		Reduction in Average Annual Damages (percent)
1	790		5
2	1,000		6
4	1,080		6
5	1,040		7
6	1,140		5
7	410		6
8	1,510		7
Total	6,970	Average	6

a/ 100-year flood plain, excluding channels

Installation of the project will allow farmers to plant higher income crops in areas that are now planted with flood-resistant crops. This shift in cropping pattern will also be accompanied by an increase in yield to acres that, with the project in place will be out of the flood plain. These flood-protected acres will be more intensively cultivated. More intensive use benefits are about 1 percent of the total.

Flood damage reduction will affect approximately 510 people in the watershed. All or parts of 57 farms are located in the flood plain and will be directly affected by the project.

Installation of the project will decrease flood damages to fences, livestock, feed yards, buildings, and other permanent facilities constructed on the flood plain. Cleanup of debris after each flood and increased harvesting costs associated with sediment damage will be reduced by the project. Dirt in the harvested grain will also be reduced. Benefits from these reduced other agricultural damages will amount to 0.1 percent of the total benefits.

Installation of the project will reduce bridge and culvert construction and maintenance costs through reduced flood flows and control of gullies. The watershed has 117 bridges that will be directly affected by the structures. Bridge size will be reduced and grade control will be provided by the grade stabilization dams. The project benefits in reduced bridge construction costs amount to 10.0 percent of the total benefits.

Transporting, processing, and marketing of agricultural commodities will be more dependable and convenient. Crop losses will be reduced. Increased farm income will benefit local retailers. More goods and services will be used on the farm to get greater benefits from increased production potential.

Frequent closing, damage to, and loss of use of flood plain roads due to flooding will be reduced. However, detained floodwater will occasionally flood two roads and interrupt traffic during storms. Local authorities will take precautions to minimize hazard to motorists.

Road and bridge damage reduction benefits are 0.1 percent of the total benefits. The railroad system will also be benefited by the grade stabilization dams. Railroad damage reduction benefits will be 0.1 percent of the total benefits.

Leona and Severance are on the edge of the flood plain. No homes or businesses are in the flooded areas. The project will reduce the maximum 100-year flood depth from 8 feet to 4 feet at Leona and from 5 feet to 2 feet at Severance, based on analysis by approximate methods. This will benefit cropland, streets, and a few outbuildings in each community.

Sparks is entirely on the flood plain. The project is estimated (by approximate methods) to reduce the maximum 100-year flood depth from 6½ feet to 4½ feet. As the community will be entirely flooded in either case, no significant benefit is anticipated.

Severe flooding occurred June 12, 1967. If this storm occurred now, flood damages would be about $754,000 based on WRC 1988 projected current normalized crop prices and 1988 prices for other items. Installation of the project would reduce the damages from a similar storm to $708,700, a 6 percent reduction.

Land Use and Prime Farmland Impacts

Land use with the project in place is shown in Table Y. See Tables J and M for comparison of present and projected without project land use.

Table Y - Future Land Use With Project

Land Use	100-Year Flood Plain		Upland		Total		
	%	Acres	%	Acres	%	Acres	
Cropland	81	5,680	61	40,000	63	45,680	
Pastureland	5	340	26	17,070	24	17,410	
Forestland	7	480	5	3,340	5	3,820	a/
Other Land	1	50	5	3,390	5	3,440	b/
Stream Channel and Ponds	6	420	1	640	1	1,060	
Gullies	-	-	2	1,630	2	1,630	
TOTAL	100	6,970	100	66,070	100	73,040	

a/ Does not include a possible 43 acres of forestland established for compensation (see page 56 for discussion of options).

b/ Includes 66 acres of dams and spillways seeded to native grass and managed for wildlife habitat compensation.

The 16 planned dams will directly change land use as shown in Table Z. Table VII, Appendix C, shows acreage by dam site.

Table Z - Land Use at Grade Stabilization Dams (acres)

Project Land Use	Present Land Use				Total
	Crop-land	Grass-land	Forest-land	Other	
Dams and Spillways	12	38	13	3	66
Sediment Pools	36	110	39	4	189
Detention Pools	52	54	40	9	155
Total	100	202	92	16	410

At maximum flood detention, a total of 344 acres will be inundated. Individual detention pools will be filled an average of once every 25 years or less frequently (see Table 3).

Reduced flooding on 1,380 acres will result in about 330 acres being classed as prime farmland. Reduced erosion will prevent 250 acres from losing classification as prime farmland. Structures will occupy 10 acres of existing prime farmland. A net increase of 570 acres of prime farmland will result. Additionally, 570 acres of existing prime farmland will benefit from reduced flooding and 10,700 acres will benefit by reduced erosion.

Wildlife Habitat Impacts

The installation of some waterways seeded to a native grass mix will change the cover type of some terrestrial wildlife habitat. Installation of the 42 land treatment structure systems will increase wildlife habitat by 623 units. There will be minor benefits to fishery habitat due to land treatment structure systems.

Dams and reservoirs will replace 189 acres of terrestrial habitat with aquatic habitat and modify an additional 66 acres of terrestrial habitat. The creation of a permanent water source will be beneficial to some wildlife.

Sponsors will compensate all terrestrial wildlife habitat losses caused by dams. Wildlife habitat changes induced by the project are summarized in Table AA. Habitat losses are shown for each proposed dam in Tables VII, Appendix C. Tables VIII and IX also show alternative compensation methods and resulting areas needed to achieve compensation. Table VI summarizes total watershed habitat units with and without the project. Future wildlife habitat units without the project was estimated at 192,900 units and 198,000 with the project.

Table AA - Impact on Wildlife Habitat at 16 Grade Stabilization Dams 20/

Habitat Type	Habitat Value a/ Loss Before Compensation	Compensation	Net change
Riparian	303	303	--
Odd Area	23	23	--
Total Forestland	326	326	--
Grassland b/	507	660	153
Cropland	122	--	-122
Total Herbaceous	629	660	+ 31

a/ Value listed in habitat units. Habitat units equal rated quality value (1 to 10) multiplied by acres. See Table VII, Appendix C. These caculations were made from data collected by the Triagency Team in 1979. 27/

b/ Category includes rangeland and pastureland.

Nationally endangered or threatened species that could occur in the watershed include the bald eagle and peregrine falcon. 24/ The alternatives will not effect these birds. 25/ There are no permanent resident state-listed threatened or endangered species which will be adversely affected. 27/ (See also references 4/ and 17/.)

Water Quality Impacts

The recommended plan will have a significant impact on water quality, especially pollutant sediment. The sediment yield will be reduced 44 percent from the projected future without project condition. This reduction is achieved primarily by the control of 47 percent of the watershed by grade stabilization dams and structures. The associated pollutants including phosphorus, nitrate-nitrogen, and pesticides will also be reduced. With the recommended plan these reductions are expected to be significant enough to restore some of the designated uses including aquatic life, groundwater recharge, and non-contact recreation.

On land controlled by grade stabilization dams and structures, sediment yield will be reduced up to 95 percent. Phosphorus and other attached pollutants will be reduced up to 90 percent. Highly mobile pollutants such as nitrate and atrazine will be reduced less. On land not controlled by grade stabilization dams or structures, land treated with other conservation practices, pollutants will be reduced an average of 45 percent. The recommended plan will reduce the untreated acres by 60 percent. The significance of this change has a correspondingly significant effect on reducing erosion and related pollutants both on farm and in downstream receiving waters.

Additional unquantified improvement in water quality is expected as landusers use chemical management methods in conjunction with implementation of their conservation plans. The Soil Conservation Service and the Cooperative Extension Service will provide assistance to landusers on chemical management.

Other Impacts

Woodlands with vigorous, fully stocked stands of trees and undisturbed ground cover will slow runoff and improve water intake by soils. Windbreaks and shelterbelts will break up wind and assist in reducing erosion and provide added wildlife habitat.

Installation of the project will provide 263 man-years of employment during the 10-year installation period. Operation and maintenance of the structures will provide 1.6 man-years of employment annually.

Alternatives will not affect known historical or architectural sites. 11/ 28/ 38/ Twenty-one known archeological sites exist in the Wolf River Watershed District. One site near Fanning is listed in the National Register of Historic Places. 28/ Potential cultural resources affected by project measures were evaluated by the Kansas State Historical Society for SCS in accordance with federal requirements. No significant resource potential was found. 12/ 13/ 14/ 15/

If such resources are unexpectedly found during construction, SCS procedures for their protection will be implemented. SCS construction personnel will be trained in identifying cultural resources prior to issuing construction contracts.

Relationship to Other Plans, Policies, and Controls

Squaw Creek Lower Wolf Watershed is included as an element of the Missouri River Basin Management Plan, which is a water and related land resources management plan prepared by the Missouri River Basin Commission. The plan serves as a definitive, flexible guide for the development, conservation, preservation, and management of water and related land resources in the Missouri River Basin. Squaw Creek Lower Wolf Watershed is located in the Missouri River Basin Water Resources Council Area 1024.

Nearby projects of other agencies include the Missouri River Bank Stabilization and Navigation Project, a Corps of Engineers project for multipurpose development that includes navigation, bank stabilization, and recreation.

The Conservation Compliance section of the Food Security Act is estimated to accelerate the on-going land treatment program. On soils with slopes of 10 percent and greater, soil loss due to sheet and rill and ephemeral erosion will be reduced but not treated to adequate levels with "Alternate Cropping Systems." Without the project, 13,400

acres of sheet and rill and ephemeral erosion will remain untreated. Without the project, gully erosion will remain severe on cropland as well as other land uses.

The Conservation Reserve Program (CRP) section of the Food Security Act is not expected to have a significant impact on the watershed at the end of the evaluation period. The counties involved in the watershed are expected to have approximately six percent of their present cropland acres converted to CRP vegetation. About half of the acres are terraced and would require only minimal effort to convert back to cultivation. The possibility of the other acres remaining in permanent vegetation through the project evaluation period is dependent upon commodity prices and government commodity program. It is estimated that less than one percent of the current cropland acres in the watershed will remain converted to permanent vegetation by the end of the 50-year evaluation period.

Squaw Creek Lower Wolf Watershed is part of the high priority problem area in the State Water Quality Plan.

CONSULTATION AND PUBLIC PARTICIPATION

In 1962, residents of the watershed area organized a steering committee to direct organization of a watershed district. Formal incorporation was granted by the Kansas Secretary of State on May 21, 1965.

Wolf River Watershed Joint District No. 66 submitted a watershed application to SCS on December 16, 1965. This application was filed with the Governor's Watershed Review Committee on January 3, 1966. A field examination team and other interested individuals toured the watershed, identified watershed problems, and recommended solutions. The field examination team was composed of representatives from the State Conservation Commission; Kansas Water Resources Board; Kansas State Board of Agriculture, Division of Water Resources; U.S.D.A., SCS; U.S.D.A., Forest Service; Kansas Fish and Game Commission; and Kansas Extension Service. A public meeting was held April 19, 1966, at the Leona school. A Field Examination Report was prepared summarizing the team's findings and recommendations. The State approved the watershed application on May 2, 1966. Priority No. 59 was assigned by the Kansas Watershed Review Committee.

Initial planning results were presented to sponsors in a Preliminary Watershed Investigation Report dated February 1969. The Administrator of SCS approved planning assistance on July 22, 1969.

On March 23, 1972, after a series of meetings and solicitation of public input, the sponsors formulated a tentative system of structural and land treatment measures. Timely progress toward completion of planning was interrupted by a reduction in SCS planning personnel coupled with additional requirements of the National Environmental Policy Act and the Water Resources Council's Principles and Standards. Objectives were broadened to include other national, environmental, special interest group, and sponsor objectives. An environmental evaluation was made for the watershed. A wide range of land and water resource factors were considered by an interagency, interdisciplinary team to scope the environmental evaluation. An interdisciplinary team also assisted sponsors to formulate an environmental quality plan that would most nearly satisfy national environmental objectives.

A public meeting was held on November 14, 1978, to discuss the environmental evaluation, national economic and environmental objectives, national economic development plan, environmental quality plan; and to answer questions and solicit ideas from the public. After the meeting the public was further invited to help formulate a plan. Completion of the draft plan/environmental impact statement was subsequently delayed due to problems encountered in the overall watershed project approval process at the national level.

See the Project Formulation section for more information about the planning process.

Since formal incorporation of the Wolf River Watershed Joint District No. 66, the district board has carried out a continuing program to inform and involve the general public. Some activities of this program are listed below:

1. Monthly or on-call meetings open to the public have been held. Specialists have usually been available to discuss watershed problems and planning needs.

2. Annual meetings, advertised in advance in the principal county newspapers, have been held.

3. Meetings have been held as necessary between watershed board representatives and officials of city, townships, county and state governments, and other sponsors.

4. Frequent person-to-person contacts have been made between watershed directors and individual farmers to explain the program and encourage application of land treatment measures.

Conservation districts have an active role as sponsors of the proposed watershed program. News media, business people, and others are backing the project. Residents and landowners in the watershed have had substantial opportunity to participate in formulating project objectives and alternative actions.

A team of biologists investigated proposed structure sites in the watershed to evaluate wildlife habitat and estimate losses. 27/ Alternatives to compensate for projected losses were developed by SCS and presented to the sponsors. 20/ The SCS and sponsors worked together to determine the maximum habitat replacement consistent with sponsor capabilities to provide land rights, operation and maintenance. The watershed district board adopted a policy of total compensation for wildlife losses from project construction. 34/

A Forestry Work Plan 4/ was developed by the State and Extension Forester, Kansas State University, and the Forest Service, and its features were included in project formulation.

The Kansas State Historical Society surveyed archeological, architectural, and historical resources in the watershed and the impact of the proposed project on these resources. 14/ 15/

The Kansas State Historic Preservation Officer was asked to determine if any cultural resources or historic sites would be adversely affected by the project. His literature search and on-site investigations by the Kansas State Historical Society determined that none would be affected.

The U.S. Fish and Wildlife Service was asked to identify threatened and endangered wildlife species that might be found in the watershed and assess the project effects. Their representatives identified two species, the bald eagle and the peregrine falcon, that

could occur within the watershed. They concluded that the project would not have any adverse effect on these species.

A public meeting was held on December 3, 1986, to review and discuss the draft plan and environmental impact statement. A question and answer session was part of the meeting.

The following agencies, conservation groups, and organizations were asked to comment on the draft plan and environmental impact statement:

Department of the Army
Department of Commerce
Department of Health and Human Services
Department of the Interior
Department of Transportation
Division of Budget (State Clearinghouse)
Environmental Protection Agency
Department of Housing and Urban Development
National Park Service
Friends of the Earth
Governor of Kansas
Kansas State Historical Society
Kansas Water Office
National Audubon Society
National Wildlife Federation
Natural Resources Defense Council
Office of Equal Opportunity USDA
Sierra Club

See Appendix A for letters of comment received.

Comments received from the following agencies either provided concurrence or did not raise environmental issues:

Department of the Army
Department of Commerce
Department of the Interior
Environmental Protection Agency
Department of Housing and Urban Development
Kansas Fish and Game Commission
Kansas State Historical Society
Kansas Geological Survey
Department of State and Extension Forestry

Each environmental issue, problem, or objection raised during interagency review is presented and discussed.

In November 1988 the Wolf River Watershed Joint District No. 66 made an application for P. L. 566 assistance covering the Squaw Creek Lower Wolf Watershed. A watesrhed plna/EIS was prepared for the Squaw Creek Lower Wolf Watershed.

LIST OF PREPARERS AND QUALIFICATIONS

SQUAW CREEK LOWER WOLF WATERSHED PLAN
AND ENVIRONMENTAL IMPACT STATEMENT

FORMAT:

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BRUCE STEBBINGS - U.S. Fish and Wildlife Biologist (20); BS-Zool.

DEBORAH R. STRONG - Manager, Wolf River Watershed Joint District No. 66 (3); Bachelor's Degree in Physical Education; various courses in geology, economics, water resources, and agricultural conservation; Teacher (4); Experience in Business and Office Management; Member SAKW, Basin Advisory Committee, Industrial Development Board.

BRUCE TAGGART - KFGC Regional Fisheries Supervisor (7); BS-Zool., MS-Environ. Biol.; fish science; Hatchery Biol. (3), River Basin Planner (1); Member of Neosho Basin Advisory Committee.

LAWRENCE H. WETTER - SCS Planning Engineer (1); Hydraulic Engineer (10); BS- Agric. Engr., MS-Civil Engr. (Hydrol.); hydrometeorology, dam break/dam routing, analysis of watersheds and river systems; SCS Area Agric. Engr. (2), Hydraul. Research Asst. (2), County Engr. (roads, bridges) (3), SCS Civil Engr. (project constr. dams) (7); Registered Prof. Engr. Kansas License No. 5325.

ROBERT D. WOOD - Wildlife Ecologist (3); BS-Wildlife Mngmt.; KFGC Environmental Liason Biologist (12); KFGC Game Biol. (10); Certified Wildlife Bio. T.W.S.

The preparers of this document include various consultants in addition to the members of the Interdisciplinary Team and the Triagency Team.

Reservoir topographic maps were provided by Bucher and Willis Engineers, Burgwin and Martin Engineers, and Casper Engineering. Bucher and Willis also provided project maps. Wilson and Company Engineers performed preliminary design and drafting. Cook, Flatt and Strobel Engineers made hydraulic studies and bench mark surveys. Van Doren, Hazard and Stallings Engineers did hydraulic studies and mapping. Geologic investigations were made by Wichita Testing Laboratory.

The Highland Community Junior College conducted an assessment of the existing environment within Wolf River Watershed. 35/ The study team consisted of staff and students in the college's biology department.

The U.S. Geological Service had a cooperative agreement with SCS to make flow measurements, install single-stage samplers, run chemical and sediment analyses, and provide a report of the results. The study involved several watersheds in northeastern Kansas including the Wolf River Watershed.

The draft watershed plan and environmental impact statement was reviewed by SCS staff at the field, state, and Midwest National Technical Center levels by specialists having responsibility for engineering, soils, agronomy, range conservation, biology, forestry, geology, hydrology, economics and recreation.

INDEX

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LIST OF APPENDICES

A P P E N D I X A

Letters and Oral Comments on Draft Plan/EIS

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
700 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

REPLY TO ATTENTION OF:

January 15, 1987

Environmental Resources
Branch
Planning Division

Mr. James N. Habiger
State Conservationist
Soil Conservation Service
760 South Broadway
Salina, Kansas 67401

Dear Mr. Habiger:

The Kansas City District, Corps of Engineers (KCD) is providing the following comments in response to your November 20, 1986 request for review of your office's draft Wolf River Watershed Plan and Environmental Impact Statement (Plan/EIS), Atchison, Brown, and Doniphan Counties, Kansas. KCD's comments are divided between permit requirements and civil works, as follows:

Permit Requirements

a. The discharge of dredged or fill material in waters of the United States, which include lakes, streams, rivers, and wetlands, requires prior authorization from the Corps of Engineers under Section 404 of the Clean Water Act (33 USC 1344). This regulatory jurisdiction is administered under Federal regulations 33 CFR 320-330.

b. Our review of the information submitted in the Plan/EIS reveals that the proposed watershed plan will include the discharge of fill material into waters of the United States for the construction of farm ponds. However, Section 404(f)(1)(c) of the Clean Water Act exempts farm and stock ponds from regulation by the Department of the Army (DA). Therefore, a DA permit will not be required for the work proposed in the Wolf Creek Watershed Plan/EIS.

c. Although a DA permit will not be required for the proposed watershed plan, this does not preclude the possibility that state and/or local permits may be required and you should satisfy yourself in this regard. If you have any questions concerning DA permits, feel free to write Mr. M.D. Jewett or call Mr. Bill DeMar at 816-374-5643.

Civil Works

a. A review of our files indicates that the KCD has no authorized or proposed civil works actions which would affect or be affected by either the recommended plan or any of the alternative plans.

b. KCD does, however, have two emergency bank protection projects (one completed, one under study) located within the Wolf River Watershed. Both of these projects, authorized under Section 14 of the Flood Control Act of 1946 (P.L. 79-526), as amended, are bridge protection actions and are located on the Middle and South Forks of the Wolf River, as shown on the enclosed map.

c. Your office is requested to contact KCD and coordinate any future actions which might be taken under the "566" or any other SCS program in the immediate vicinity of these "Section 14" projects.

The KCD appreciates the opportunity to review and comment on your draft Plan/EIS. If you need any additional information or have any questions regarding these comments, please contact Mr. Martin R. Schuettpelz of my staff at 816-374-5063.

Sincerely,

Philip L. Rotert
Chief, Planning Division

Enclosure

No response necessary

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE COMPTROLLER

January 5, 1987

Mr. James N. Habiger
State Conservationist
U.S. Department of Agriculture
Soil Conservation Service
760 South Broadway
Salina, Kansas 67401

Dear Sirs:

This is in reference to your draft supplement to the environmental impact statement for the Wolf River Watershed, Kansas. Enclosed are comments from the National Oceanic and Atmospheric Administration.

We hope our comments will assist you. Thank you for giving us an opportunity to review the document.

No response necessary

Sincerely,

David Cottingham

David Cottingham
Ecology and Conservation Division

Enclosure

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
WASHINGTON, D.C. 20240

TAKE PRIDE IN AMERICA

JAN 20 1987

ER 86/1422

Mr. James N. Habiger
State Conservationist
Soil Conservation Service
760 South Broadway
Salina, Kansas 67401

Dear Mr. Habiger:

We have reviewed the draft environmental statement and watershed plan for Wolf River Watershed, Atchison, Brown, and Doniphan Counties, Kansas.

Our review did not surface any conflicts with programs or missions of this Department; therefore, we have no objection to the findings and recommendations discussed in your watershed plan.

Sincerely,

Bruce Blanchard
Director

No response necessary

STATE OF KANSAS

Mike Hayden, Governor

KANSAS WATER OFFICE
Joseph F. Harkins
Director

Suite 200
109 SW Ninth
Topeka, Kansas 66612-1215

913-296-3185

January 20, 1987

Mr. James N. Habiger
State Conservationist
Soil Conservation Service
U.S. Department of Agriculture
760 South Broadway
Salina, KS 67401

Dear Mr. Habiger:

I am writing concerning the draft watershed plan and environmental impact statement for the Wolf River Watershed. As requested in your letter of November 20, 1986 to former Governor John Carlin, this office has coordinated a review of the draft by state agencies.

Five agencies commented on the draft, with the Kansas Biological Survey and the Kansas Department of Health and Environment providing more extensive suggestions for consideration. In his letter to me dated December 31, 1986, Mr. Donald Snethen of the Kansas Department of Health and Environment made the following suggestions.

1. The plan should promote a multipurpose structure to address general drinking water problems in the area.

2. The effects of sediment on aquatic life and recreation should be addressed in more detail along with information on addressing this problem.

3. The discussion of water quality on page 23 should be replaced with the statement provided.

Dr. Edward Martinko, Director of the Kansas Biological Survey, makes the following suggestions in his letter of January 8, 1987:

Continued

Comment 1 - The City of Hiawatha was contacted. The city informed us that the proposed multipurpose site investigated during planning is still too expensive for them. They may reconsider later. We have revised paragraph 3, page 23, to read, ". . . Appendix C.) . . . The City of Hiawatha was contacted again in January 1987 regarding sponsorship of a multipurpose site. They were not interested. At this printing water-based recreation and water supply do not have a sponsor. Plan modification will be considered at such time as a multipurpose sponsor(s) is willing to carry out the local responsibilities of a multipurpose site."

Comment 2 - Even though the project will significantly decrease the amount of sediment, stream classification and expected stream uses will not be changed. These changes have been alluded to on page 78. Because of the lack of data, we will not attempt to further quantify these project effects.

Comment 3 - The suggested revision has been included on page 23 and a supporting table added to Appendix C.

1. The role of past and present land-use practices in contributing to excessive erosion should be noted.

2. The effect retention of sediment within the uplands would have on the Wolf River should be more thoroughly analyzed.

3. The benefits of periodic flooding with respect to soil fertility should be weighed against those of flood abatement where such abatement is most critical at present.

4. The total storage capacity of all water retention structures would not be at a maximum at the same time because these structures would be built over a period of years.

Copies of all comments received are attached to this letter.

I wish to comment on the agricultural, municipal and industrial water supply development discussion in the first paragraph on page 43. The Kansas Water Plan - Missouri Basin Section identifies projected municipal and industrial water supply shortages as a problem for future action. Such shortages are anticipated in areas not having direct access to the Missouri River. While Hiawatha, Kansas, is not mentioned specifically, we intend to investigate this situation further using the latest available supply and demand projections.

As you know, Kansas now has a multipurpose small lakes program whereby state financial assistance can be provided when, for example, a municipality wishes to add a water-supply function to a new reservoir being designed for flood control purposes. While the City of Hiawatha may be unable to finance the nonfederal share of a reservoir alone, the possibility exists that such a structure might be built utilizing the multi-purpose small lakes program.

With this possibility in mind, I request that the recommended plan include a water supply structure for the City of Hiawatha as suggested by Mr. Donald Snethen in his comments. The structure could be located as described on page 43. In order that the plan not be unduly delayed, I suggest that two options for such a structure be included; a multipurpose structure and a single purpose structure for flood protection only. The appropriate option could be selected at a later date when all needs had been assessed.

Continued

Comment 1 - A discussion of past and present land use practices has been included in the Project Setting section, page 9, of the Plan.

Comment 2 - A paragraph discussing the sediment reduction effects to Wolf River has been added to page 78.

Comment 3 - Benefits associated with periodic flooding in Wolf River are insignificant. The amount and duration of flooding as well as topography are not conducive to fertility increases due to flooding. Cultural practices, including fertilizer application, overshadow any potential benefit from flooding. In addition, large floods will still flood about the same land area as without the project.

Comment 4 - Costs and benefits during construction have been discounted and annualized over the project life at a specific interest rate (see Tables 4 and 6). Maximum floodwater storage will be reached in the 10th year or when the last structure is built. Floodwater storage is the storage capacity between the principal spillway outlet and the emergency spillway outlet. This storage will continue to be available even when the sediment storage capacity has filled with sediment as long as the dam is functional. (See Table 3 for sediment and floodwater volumes.)

1 In addition, I request that the water quality information provided by Mr. Snethen in Item No. 4 in his letter be incorporated into the final plan and that the other comments by Mr. Snethen and Dr. Martinko be considered as well.

Thank you for the opportunity to review this draft. For your information, the Missouri Basin Section of the Kansas Water Plan contains a recommendation that the general plan for the Wolf River Watershed should be reviewed and revised, if necessary, to ensure that it adequately addresses the effects of stream channelization. Subject to the revisions mentioned and the review necessary regarding stream chanelization, the State of Kansas recommends that the Wolf River Watershed-Watershed Plan and Environmental Impactment Statement be adopted.

Sincerely,

Joseph F. Harkins
Director

JFH:dk
Attachments
cc: The Honorable Mike Hayden, Governor of Kansas
Dr. Edward Martinko, Kansas Biological Survey
Donald Snethen, Kansas Department of Health and Environment
Glen Kirk, Kansas Water Office

1 Refer to previous comments in this letter

State of Kansas . . . John Carlin, Governor

DEPARTMENT OF HEALTH AND ENVIRONMENT

Barbara J. Sabol, Secretary

Forbes Field
Topeka, Kansas 66620-0110
913-862-9360

December 31, 1986

Joseph Harkins
Kansas Water Office
Suite 200, 109 SW 9th
Topeka, Kansas 66612-1215

Dear Mr. Harkins:

THe Kansas Department of Health and Environment - Bureau of Water Protection has reviewed the Draft Watershed Plan and Environmental Impact Statement for the Wolf River Watershed Joint District No. 66 located in Atchison, Brown, and Doniphan Counties Kansas. We expect water quality conditions in the Wolf River to improve as this plan is implemented. The installation of the enduring land treatment practices is an important first step and we encourage prompt implementation of these practices. We do however, offer a number of comments which if added to the plan will strengthen the overall plan.

1. The City of Hiawatha is reportedly short of water but hasn't done anything about it. The plan should promote a multi-purpose structure to address general drinking water problems in the area (Hiawatha, Bendena, and Rural Water Districts). If drinking water supply lakes and recreational lakes are added to the plan, the Kansas Department of Health and Environment - Bureau of Water Protection should be contacted in the early stages of design.

2. Erosion and sedimentation are noted as severe problems in the watershed and are discussed in several places. However most of the discussion is directed to "on-site" problems of soil loss and the resulting loss of productivity, nutrients and chemicals. "Off-site" problems related to effects of sediment on aquatic life (deposition covering habitat, bio-accumulation of chemicals, eutrophication of pools, ponds and/or lakes) and recreation (turbidity) should be addressed in more detail along with information on how the plan will address these problems.

3. Currently, we have found and are studying pesticides in large lakes in Kansas. Little information is available on the fate of pesticides in small reservoirs. Consequently, we encourage land treatment, applicator education, and other methods which will reduce pesticide loss to streams and ponds. As the Plan is implemented, the Watershed District, SCS and KDHE should work closely to ensure safe water exists in the impoundments.

4. The plan has a brief discussion (page 23) of water quality and the relationship of Kansas Water Quality Standards to the project. While the discussion is not completely inaccurate, it is misleading in that it suggests that the Wolf River has no water quality problems and the project will have no impact on water quality. We request that serious consideration be given to replacing this statement with the following:

> The Wolf River is subject to Kansas Surface Water Quality Standards (KAR 28-16-28b through 28f) administered by the Kansas Department of Health and Environment (KDHE). Under Kansas Water Quality Standards, designated uses of Wolf River include agricultural water supply, industrial water supply, and non-contact and consumptive recreation.
>
> KDHE maintains a water quality monitoring station on the Wolf River near Sparks. Table 1 (attached) provides a summary of water quality data for this site as well as 7 other reference sites. In general, the water quality of Wolf River is currently suitable for attainment of the designated uses. However, in comparing Wolf River water quality to the 7 reference sites, we find that Wolf River has been degraded by agricultural nonpoint source pollutants. We also conclude that Wolf River water quality will continue to deteriorate unless corrective action is taken at this time. The aquatic life support use is at greatest risk. Furthermore, the citations (page 23) of references 35 (Wolf River Research ___ The Wolf in the Rise...) and 37 (Effect of Suspended Solids ... EPA 60013-79-042) suggest that the aquatic life support use may currently only be marginally attained.

Thank you for the opportunity to comment on the Work Plan and Environmental Impact Statement for Wolf River Watershed District No. 66. If we can provide any assistance or further information please contact us.

Sincerely,

Donald D. Snethen, P.E., Chief
Water Quality Assessment Section
Bureau of Water Protection

DS66

Attachment
c: Gyula Kovach
LaVene Brenden
Bob Dreese, SCS Salina

Table 1. Comparison of water quality parameters from Pony Creek and other local and "control" areas. All data are mean values for the period of record (1975 to June 1986).

LOCATION	TOTAL PHOS. (mg/1)	TOTAL AMMONIA NITROGEN (mg/1)	NITRITE/ NITRATE NITROGEN (mg/1)	TURB-IDITY (NTU)	BOD (mg/1)	FECAL COLI-FORM (#/100 ml)	FECAL STREP (#/100 ml)	MBI*
PLANNING AREA								
Wolf River (near Sparks)	0.52	0.20	4.0	187	2.5	12,307	26,014	4.81
LOCAL AREA								
Walnut Cr. (at Reserve)	0.39	0.21	3.5	109	2.6	3,584	13,272	na
Pony Cr. (near Reserve)	0.34	0.17	4.5	119	2.3	9,762	22,089	na
S. Fk. Nemaha (at Bern)	0.52	0.21	1.6	161	2.8	15,857	23,709	5.02
Delaware River (at Muscotah)	0.34	0.08	1.6	106	2.2	4,892	15,259	4.51
CONTROL AREAS								
Kansas R. (at Wamego)	0.33	0.16	1.0	103	2.2	2,213	3,453	4.33
Cottonwood R. (at Plymouth)	0.17	0.11	0.7	55	2.6	1,676	4,153	4.29
Kill Cr. (at DeSoto)	0.22	0.23	1.0	47	2.9	3,556	8,904	na

*MBI Macroinvertebrate biotic index - a numerical index ranging from 1.5 to 11 that combines the organic pollution tolerance of benthic organisms which estimates community structure to determine the general relationship of these benthic communities to water quality. Lower index numbers indicate higher quality water.

See our response to comments in letter from Joe Harkins, Kansas Water Office.

KANSAS BIOLOGICAL SURVEY

The University of Kansas

Raymond Nichols Hall
2291 Irving Hill Drive—Campus West
Lawrence, Kansas 66045-2969
(913) 864-4777

January 8, 1987

Joseph F. Harkins, Director
Kansas Water Office
Suite 200
109 SW Ninth
Topeka, KS 66612-1215

Dear Mr. Harkins:

Thank you for the opportunity to review and comment on the draft Watershed Plan and Environmental Impact Statement for the Wolf River Watershed. In this regard I offer the following comments.

A major reason for development of the Watershed Plan appears to he to control or reduce erosion. However, the cause of the problem is not clearly stated. Perhaps it is beyond the scope of the Plan to deal with the cause(s) but it might be appropriate to state in the introduction to the "Problem and Opportunity Identification" section (page 11) that the excessive erosion is the result of past development and past and present landuse practices which are incompatible with or are inadequate for good soil conservation. Since a major portion of the "Recommended Plan" requires substantial changes in land treatment, a statement similar to this appears justifiable.

Channelization of the Wolf River was pointed out as a prime contributer to the increase in gully enlargement. The "Recommended Plan" calls for a series of watershed dams and grade stabilization structures but does not mention any alterations to the Wolf River. Perhaps the erosion effects caused by the channelization are too far advanced to be abated by alterations to the river but some physical change in the river may help in the long term. If the "Recommended Plan" is implemented and effective in reducing the silt load carried by the river, the river channel may begin to deepen at a more rapid rate than at present. The case was made that retention of sediment within the watershed could cause increased gully erosion but concurrent retention of high scour producing peak water flows would off set this erosion. Does this apply equally to the Wolf River? If not, some physical alteration in the river may be necessary to prevent channel deepening and a repetition of what resulted from the initial channelization.

As stated in the document the aquatic fauna of the watershed would be little effected by implementation of the Plan. This, for the most part, is true. The diversity of aquatic organisms in the glacial tilt portion of Kansas is somewhat less than elsehwere in the State. Watershed dams, however, generally have a negative impact on the native aquatic fauna of the intermittent and ephemeral streams upon which they are constructed. The natural fauna inhabiting intermittent and ephemeral streams are species adapted to periodic, seasonal changes. Watershed dams tend to prolong stream flow thereby changing the environment to which the species nre adapted. The result is species shifts or species loss and changes in population densities. However, due to presently existing low numbers of species in this region the watershed dams will probably be of minimal impact and perhaps enhance the overall productivity of the Wolf River by reducing stream turbidity.

Reduction of damage due to floods will be a definite economic benefit to those utilizing the flood plains. Prolonged control of flooding could have a long-term negative effect on fertility of the flood plain. Those using floodplain areas for crop land are well aware of the high yields experienced from the natural fertility of the soil. Over time, if flooding is prevented, soil nutrients will decrease and crop yields will become more similar to those in upland areas thus requiring artificial nutrient supplement to maintain the previous high yield crop production. Apparently a portion of the Wolf River watershed is experiencing the detrimental effect of having low nutrient soils deposited along with flood waters. In this instance flood reduction will be advantageous but for those not receiving low nutrient sediment deposition they may experience a long term drop in productivity with the reduction of flood occurrences. It may be benefical to compare various sections of the watershed to determine where flood reduction is most critical at present and weigh this cost benefit of abatement to the increase in cost required to maintain high productivity in areas where periodic flooding naturally recharges soil nutrients.

Details of runoff water storage and sediment capacities of the 54 grade stabilization dams is somewhat confusing when effective life span of the structures and project implementation duration are considered. The numbers given (pages 57 and 58) appear to be based on all dams being put in place simultaneously when in fact it will take about 20 years to implement the total watershed plan. If sediment storage capacity is projected to be 50 years then water storage capacity at the end of 50 years will be nearly zero. If it takes 20 years to complete all dam construction than the first dams built will be nearly half filled with sediment and retain about half as much runoff water as the later retention structures being constructed. In other words, the total maximum project storage capacities appear to be for a hypothetical and unachievable single point in time and not actual. Cost benefits based upon these capacities would, likewise, be hypothetical and unrealistic. It is my hope the annual ammortization process used took these factors into account but if not the total cost benefit of project is misleading and should be recalculated in a more realistic fashion.

The "Recommended Plan" appears to be a reasonable, well thought through attempt at solving the problems in the Wolf River watershed over the 50 year life expectancy of the project. Comments and questions raised in this letter are not meant as criticism of the Plan but rather to point out particular items that appeared unclear upon reading the document.

Sincerely,

Paul N. Liechti
Assistant Director

Edward A. Martinko
State Biologist &
Director

PNL/EAM/jkm

See our response to comments in letter from Joe Harkins, Kansas Water Office.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

January 13, 1987

Mr. James N. Habiger, State Conservationist
U.S.D.A. Soil Conservation Service
760 South Broadway
Salina, Kansas 67401

RE: Wolf River Watershed - Atchison, Brown and Doniphan Counties, Kansas

Dear Mr. Habiger:

In accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, we have reviewed the draft Environmental Impact Statement (EIS) for the Wolf River Watershed project.

We have no comments to offer on this EIS, and have no objections to the proposed action as described. Consequently, we have rated this project as Lack of Objections (LO).

Thank you for the opportunity to review and comment on this project.

Sincerely yours,

Edward C. Vest

Edward C. Vest
Chief, EIS Section

No response necessary

U.S. Department of Housing and Urban Development
Kansas City Regional Office, Region VII
Professional Building
1103 Grand Avenue
Kansas City, Missouri 64106-2496

December 9, 1986

Mr. James N. Habiger
State Conservationist
Soil Conservation Service
760 South Broadway
Salina, KS 67401

Dear Mr. Habiger:

Subject: Draft Environmental Impact Statement (EIS): Wolf River Watershed - Atchinson, Brown, and Donophan Counties, Kansas (October 1986)

This office has reviewed the subject Draft EIS for the Wolf River Watershed in northeast Kansas. The document was found to be satisfactory in meeting the spirit and intent of the National Environmental Policy Act (NEPA) and no apparent adverse impacts have been noted relating to HUD projects in this jurisdiction.

We appreciate the opportunity to comment on this matter.

Sincerely,

Lance L. Long
Environmental Officer

No response necessary

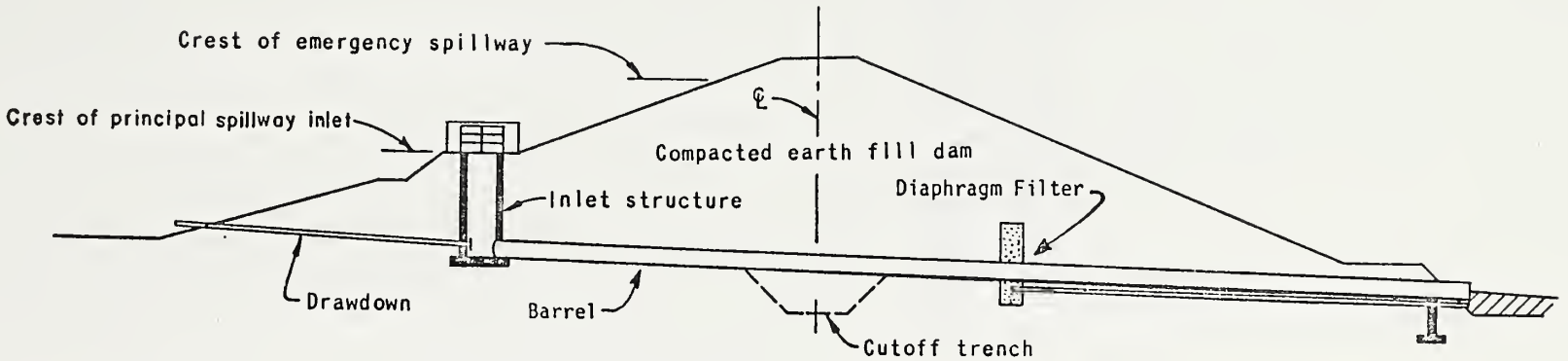
A P P E N D I X B

Support Map

Typical Earth Dam With Drop Inlet Spillway

SOIL CONSERVATION SERVICE

TYPICAL EARTH DAM WITH DROP INLET SPILLWAY



CROSS SECTION OF DAM ON CENTERLINE OF PRINCIPAL SPILLWAY

NOTES:

1. FOR INDIVIDUAL STRUCTURE DATA SEE TABLE 3.
2. EMBANKMENT AND FOUNDATION DESIGN FEATURES NOT SHOWN.

A P P E N D I X C

Supporting Information

TABLE I[a/]
Squaw Creek Lower Wolf Watershed, Kansas

POPULATION AND PROJECTIONS

	1900	1960	1970	1990	2020
United States	76,212,168	179,325,675	203,210,158	269,759,000	399,013,000
Kansas	1,470,495	2,178,611	2,246,578	2,635,000	3,720,000
Brown County	22,369	13,229	11,685	12,761	18,041
Doniphan County	15,079	9,574	9,107	11,387	18,164
Watershed[b/]	--	890	850	1,060	1,690

a/ Sources for population and projections are references 3, 5, 21, 29, and 30

b/ Watershed population has been estimated from the county trends

Minority Populations

Brown County	6.7% (mostly outside the watershed)
Doniphan County	5.6% (mostly outside the watershed)

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TABLE II[a/]

RECREATIONAL DATA - WOLF RIVER WATERSHED DISTRICT[b/]

RECREATIONAL RESOURCES

Activity (unit)	1974 Supply	1980 Demand	1980 Need	2000 Demand	2000 Need
Boating (acres)	190	6,366	6,176	6,626	6,436
Picnicking (tables)	244	203	+41[c/]	212	+32
Camping (sites)	261	89	+172	93	+168
Nature Trails (miles)	2	6	4	7	5
Beaches (lin. ft.)	17,200	212	+16,988	221	+16,979

COMPARISON OF RECREATIONAL VISITS AND DEMAND[b/]

Activity	Recreational Visits		
	1976 Supply	1978 Demand	1978 Need
Fishing	26,200	47,200	21,000
Boating	3,000	8,000	5,000

a/ Data taken from S.C.O.R.P., reference 2/.
b/ Based on a 5-county area including Atchison, Brown, Doniphan, Jackson, and Nemaha Counties
c/ A "+" denotes an excess

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TABLE III

PUBLIC WATER SUPPLY[a/]

City	Bendena	Denton	Denton	Everest	Hiawatha	Leona	Robinson
Well No.	2	2	3	5		1	7
Location	NE¼ SE¼ S33, T3S, R20E	NE¼ S10, T4S, R19E	NE¼ S10, T4S, R19E	SE¼ NW¼ NW¼ S6, T5S, R18E	SW¼ SW¼ SE¼ S32, T1S, R17E	SE¼ S18, T3S, R19E	NW¼ NW¼ S28, T2S, R18E
Date Collected	5-11-73	3-28-78	9-28-67	2-21-61	7-17-62	6-21-76	12-1-77
Total Alkalinity (as $CaCO_3$)	132 mg/l	186 mg/l	188 mg/l			118 mg/l	166 mg/l
Alkalinity ($NaHCO_3$)		0 mg/l					
Total Dissolved Solids		353 mg/l		346 mg/l	282 mg/l	210 mg/l	
Total Hardness (as $CaCO_3$)		256 mg/l	268 mg/l			124 mg/l	192 mg/l
Hardness - Carbonate		186 mg/l		244 mg/l	220 mg/l		
Hardness - Noncarbonate		70 mg/l		0 mg/l	18 mg/l	6 mg/l	
pH	6.7	8.0		7.8	7.4	7.4	7.7
Specific Conductance		600		620	490	290	
Turbidity (NTU)		0.2				0.9	
Bicarbonate (HCO_3)		227 mg/l		325 mg/l	268 mg/l	144 mg/l	
Calcium (Ca)		83 mg/l		65 mg/l	74 mg/l	42 mg/l	54 mg/l
Carbonate (CO_3)		<0.1 mg/l				0.1 mg/l	
Chloride (Cl)	31 mg/l	24 mg/l	24 mg/l	7 mg/l	7 mg/l	1 mg/l	10 mg/l
Magneisum (Mg)		12 mg/l		20 mg/l	13 mg/l	4.7 mg/l	14 mg/l
Nitrate (N)	45 mg/l	8.1 mg/l	66 mg/l (NO_3)	22 mg/l (NO_3)	15 mg/l (NO_3)	19 mg/l (NO_3)	6.2 mg/l
Potassium (K)		0.8 mg/l				0.9 mg/l	
Sodium (Na)		16 mg/l		31 mg/l	8.3 mg/l	15 mg/l	14 mg/l
Sulfate (SO_4)		45 mg/l	50 mg/l	16 mg/l	13 mg/l	24 mg/l	18 mg/l
Iron (Fe)		0.01 mg/l	0.30 mg/l	0.02 mg/l	0.08 mg/l	0.10 mg/l	0.15 mg/l
Manganese (Mn)		<0.01 mg/l	<0.01 mg/l			<0.01 mg/l	0.05 mg/l
Total Phosphorus (P)		0.09 mg/l	23 mg/l (PO_4)			0.15 mg/l (PO_4)	
Silica (SiO_2)		24 mg/l				26 mg/l	
Arsenic (AS)		<0.01 mg/l					
Barium (Ba)		0.1 mg/l					
Cadmium (Cd)		<0.001 mg/l					
Chromium (Cr)		<0.01 mg/l					
Copper (Cu)		<0.01 mg/l					
Fluoride (F)		0.25 mg/l	0.8 mg/l	0.3 mg/l	0.2 mg/l	1.0 mg/l	0.4 mg/l
Lead (Pb)		<0.01 mg/l					
Mercury (Hg)		0.002 mg/l					
Selenium (Se)		0.003 mg/l					
Silver (Ag)		<0.01 mg/l					
Zinc (Zn)		0.01 mg/l					

a/ Kansas Department of Health and Environment, communication by letter, 1979

TABLE IV

PESTICIDE CONCENTRATIONS [a/]

Location No.	Date	Total DDT µg/l	DDT Bottom Material µg/Kg	Total DDE µg/l	DDE Bottom Material µg/Kg	Total DDD µg/l	DDD Bottom Material µg/Kg	Total Dieldrin µg/l	Dieldrin Bottom Material µg/Kg	Total 2, 4-D µg/l	Total Heptachlor Epoxide µg/l	Heptachlor Epoxide Bottom Material µg/Kg	PCB Bottom Material µg/Kg
*06815880	4-26-77	0.2	2.1	0.01	0.4	0.01	0.1	0.1	1.5	NT	0.03	0.2	1
06815880	5-11-78	0.00	NT	0.00	NT	0.00	NT	0.01	NT	0.37	0.00	NT	NT
**	3-30-78	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<1
06815578	5-09-78	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.47	0.00	0.0	.0
06815570	5-09-78	0.00	0.0	0.00	0.0	0.00	0.0	0.01	0.3	0.24	0.00	0.0	.0
						FRESHWATER AQUATIC LIFE CRITERION (MICROGRAMS/LITER)							
EPA[32/]		0.001 (24 hr. Avg.) 1.1 (Maximum)						0.0019 (24 hr. Avg.) 2.5 (Maximum)			0.0038 (24 hr. Avg.) 0.52 (Maximum)		

NT -- Not Tested.

*U.S. Geological Survey hydrologic station number.

**These stations 06815570, 06815578, 06815700, 06815800, and 06815880 were sampled by SCS personnel and tested by Wilson Laboratories, Salina, Kansas, and all resulted in <1 µg/Kg concentrations.

a/ U.S. Geological Survey, Water Resources Division

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TABLE V

HISTORICAL AND PROJECTED PER CAPITA INCOME

Wolf River Watershed District, Kansas

(Dollars)[a/]

	1969	1980	1990	2000
United States[b/]	3,416	4,765	6,166	8,289
Kansas[b/]	3,340	4,725	6,139	8,241
BEA Area 111[b/]	3,377	4,733	6,104	8,203
Atchison County[c/d/]	2,348	3,287	4,250	5,703
Brown County[c/d/]	2,408	3,371	4,358	5,849
Doniphan County[c/d/]	2,360	3,304	4,271	5,732

a/ Based on 1967 dollars
b/ Data taken from reference 30/
c/ Data taken from reference 21/
d/ Projections for counties based on regional trends

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TABLE VI

HABITAT UNITS BY LAND COVER

Squaw Creek Lower Wolf Watershed, Kansas

Land Cover	Rated Value	Total Habitat Units		
		Present	Future w/o	Future w/project
HERBACEOUS				
Cropland	2.5	118,000	104,300	107,600
Pastureland	3.0	51,100	60,200	60,200
Compensation	-	-	-	1,000
Total Herbaceous		169,100	164,500	168,800
WOODY				
Riparian	6.2	21,900	21,300	21,000
Upland	4.1	4,800	4,700	4,700
Compensation	-	-	-	300
Total Woody		26,700	26,000	26,000
AQUATIC				
(Stream)				
Ephemeral	2.9	410	410	380
Intermittent	3.4	260	260	230
Perennial	3.9	930	930	890
Total Stream		1,600	1,600	1,500
(Flatwater)				
Pond, Lake	4.8	770	770	1,680

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TABLE VII
WILDLIFE HABITAT UNIT LOSS FOR ALTERNATIVE GRADE STABILIZATION DAMS
BEFORE COMPENSATION

Squaw Creek Lower Wolf Watershed, Kansas

Original Site No.	Planned Acreage		Cropland		Pastureland		Rangeland		Riparian Woodland		Upland Woodland		Odd Area		Wetland Habitat		H.U. Potential in Dam & Spillway
	Dam & Spwy.	Sed. Pool	Acres	H.U.	Acres	H.U.	Acres	H.U.	Acres	H.U.	Acres	H.U.	Acres	H.U.	Acres	H.U.	
2-11	2	5	-	-	1	3	-	-	6	27	-	-	-	-	-	-	20
2-15A	7	11	3	8	6	12	-	-	7	45	-	-	2	3	-	-	70
3-4A	3	14	11	28	-	-	-	-	6	36	-	-	-	-	-	-	30
5-1B	5	27	2	5	28	84	-	-	2	12	-	-	-	-	-	-	50
5-3	3	8	2	5	4	12	-	-	5	31	-	-	-	-	-	-	30
5-8	4	14	-	-	14	42	-	-	4	25	-	-	-	-	-	-	40
5-9	4	7	2	5	9	27	-	-	-	-	-	-	-	-	-	-	40
5-15	3	8	2	5	8	24	-	-	1	6	-	-	-	-	-	-	30
5-16	3	9	10	25	-	-	-	-	-	-	-	-	2	10	-	-	30
6-4A	4	9	11	28	-	-	-	-	-	-	-	-	2	10	-	-	40
6-5A	6	21	2	5	18	54	-	-	6	37	-	-	-	-	1	8	60
6-12A	3	8	-	-	3	9	-	-	8	43	-	-	-	-	-	-	30
6-13A	6	14	-	-	18	65	-	-	2	10	-	-	-	-	-	-	60
7-3	2	3	-	-	4	12	-	-	1	6	-	-	-	-	-	-	20
7-11	8	24	3	8	-	-	29	145	-	-	-	-	-	-	-	-	80
8-7	3	7	-	-	6	18	-	-	4	25	-	-	-	-	-	-	30
	66	189	48	122	119	362	29	145	52	303	-	-	6	23	1	8	660

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TABLE VIII
WILDLIFE HABITAT COMPENSATION ALTERNATIVES[a/]
Squaw Creek Lower Wolf Watershed, Kansas

Site Number	Habitat Units Lost		Habitat Units to be Compensated		Alternative 1 [b/] Acres to be Revegetated		Alternative 2 [b/] Est. Acres to be Preserved		Net Change (Habitat Units)
	Woodland	Herbaceous	Woodland	Herbaceous	Woodland	Herbaceous	Riparian Woodland	Based upon 10-R Value of	
2-11	27	3	27	3	3.6	2	7.1	3.8	+17H
2-15A	48	20	48	20	6.4	7	12.6	"	+50H
3-4A	36	28	36	28	4.8	3	9.5	"	+ 2H
5-1B	12	89	12	50	1.6	5	3.2	"	-39H
5-3	31	17	31	17	4.1	3	8.2	"	+13H
5-8	25	42	25	40	3.3	4	6.6	"	- 2H
5-9	--	32	--	32	--	4	--	"	+ 8H
5-15	6	29	6	29	0.8	3	1.6	"	+ 1H
5-16	10	25	10	25	1.3	3	2.6	"	+ 5H
6-4A	10	28	10	28	1.3	4	2.6	"	+12H
6-5A	37	59	37	59	4.9	6	9.7	"	+ 1H
6-12A	43	9	43	9	5.7	3	11.3	"	+21H
6-13A	10	65	10	60	1.3	6	2.6	"	- 5H
7-3	6	12	6	12	0.8	2	1.6	"	+ 8H
7-11	--	153	--	80	--	8	--	"	-73H
8-7	18	25	18	25	3.3	3	6.6	"	+12H
	319	636	319	517	43.2	66	85.8		+31H

a/ Compensation for problem area solutions using large grade stabilization dams. Other solutions may require different compensation.

b/ Either Alternative 1 or Alternative 2 will compensate for all losses on the site. A combination of the two alternatives may be selected to compensate for all losses.

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TABLE IX

LAND TREATMENT IMPACTS ON WILDLIFE
HABITAT ON 42 LAND TREATMENT STRUCTURE SYSTEMS

Squaw Creek Lower Wolf Watershed, Kansas

Number of Units	Diversions[a/] - 62.4 acres			Grade Stab.[b/] - 81.5 acres		
	Crop 83%	Grass 14%	Forest-land 3%	Crop 59%	Grass 27%	Forest-land 14%
42	51.8	8.7	1.9	48.1	22.0	11.3
H.U. Value	3.5	3.5	4.0	3.5	3.5	4.0
H U. Loss	181	30	8	168	77	45
Total H.U. Loss		211	8		245	45
Acres Planted[c/] to Native Grass	62.4		d/	81.5		d/
H.U. Value	7.5			7.5		
Total H.U. Gain	468			611		
Net Gain from Conversion	257		d/	366		d/

a/ Average 1,713 linear feet of diversion per unit = 1.49 ac./unit
b/ Average 2.42 grade stab. per unit - 1.94 ac./unit
c/ Includes all of construction area for diversions and grade stab. structures. If only back slope of diversions are seeded, the acreage will be approximately 25 percent of this total.
d/ Forestland loss will be replaced with shrub plantings in conjunction with native grass plantings.

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TABLE X

COMPARISON OF WATER QUALITY PARAMETERS
FROM PONY CREEK AND OTHER LOCAL AND "CONTROL" AREAS

All data are mean values for the period of record (1975 to June 1986)

LOCATION	TOTAL PHOS. (mg/l)	TOTAL AMMONIA NITROGEN (mg/l)	NITRITE/ NITRATE NITROGEN (mg/l)	TURB-IDITY (NTU)	BOD (mg/l)	FECAL COLI-FORM (#/100 ml)	FECAL STREP (#/100 ml)	MBI[a/]
PLANNING AREA								
Wolf River (near Sparks)	0.52	0.20	4.0	187	2.5	12,307	26,014	4.81
LOCAL AREA								
Walnut Cr. (at Reserve)	0.39	0.21	3.5	109	2.6	3,584	13,272	na
Pony Cr. (near Reserve)	0.34	0.17	4.5	119	2.3	9,762	22,089	na
South Fork Nemaha (at Bern)	0.52	0.21	1.6	161	2.8	15,857	23,709	5.02
Delaware River (at Muscotah)	0.34	0.08	1.6	106	2.2	4,892	15,259	4.51
CONTROL AREAS								
Kansas R. (at Wamego)	0.33	0.16	1.0	103	2.2	2,213	3,453	4.33
Cottonwood R. (at Plymouth)	0.17	0.11	0.7	55	2.6	1,676	4,153	4.29
Kill Cr. (at DeSoto)	0.22	0.23	1.0	47	2.9	3,556	8,904	na

a/ MBI Macroinvertebrate biotic index - a numerical index ranging from 1.5 to 11 that combines the organic pollution tolerance of benthic organisms which estimates community structure to determine the general relationship of these benthic communities to water quality. Lower index numbers indicate higher quality water.

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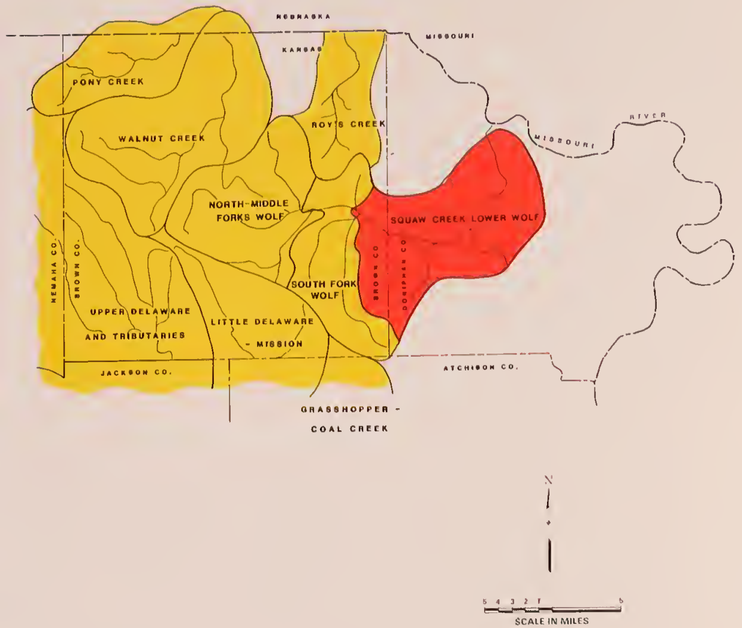
A P P E N D I X D

Project Map

WATERSHED PROJECT LOCATION MAP



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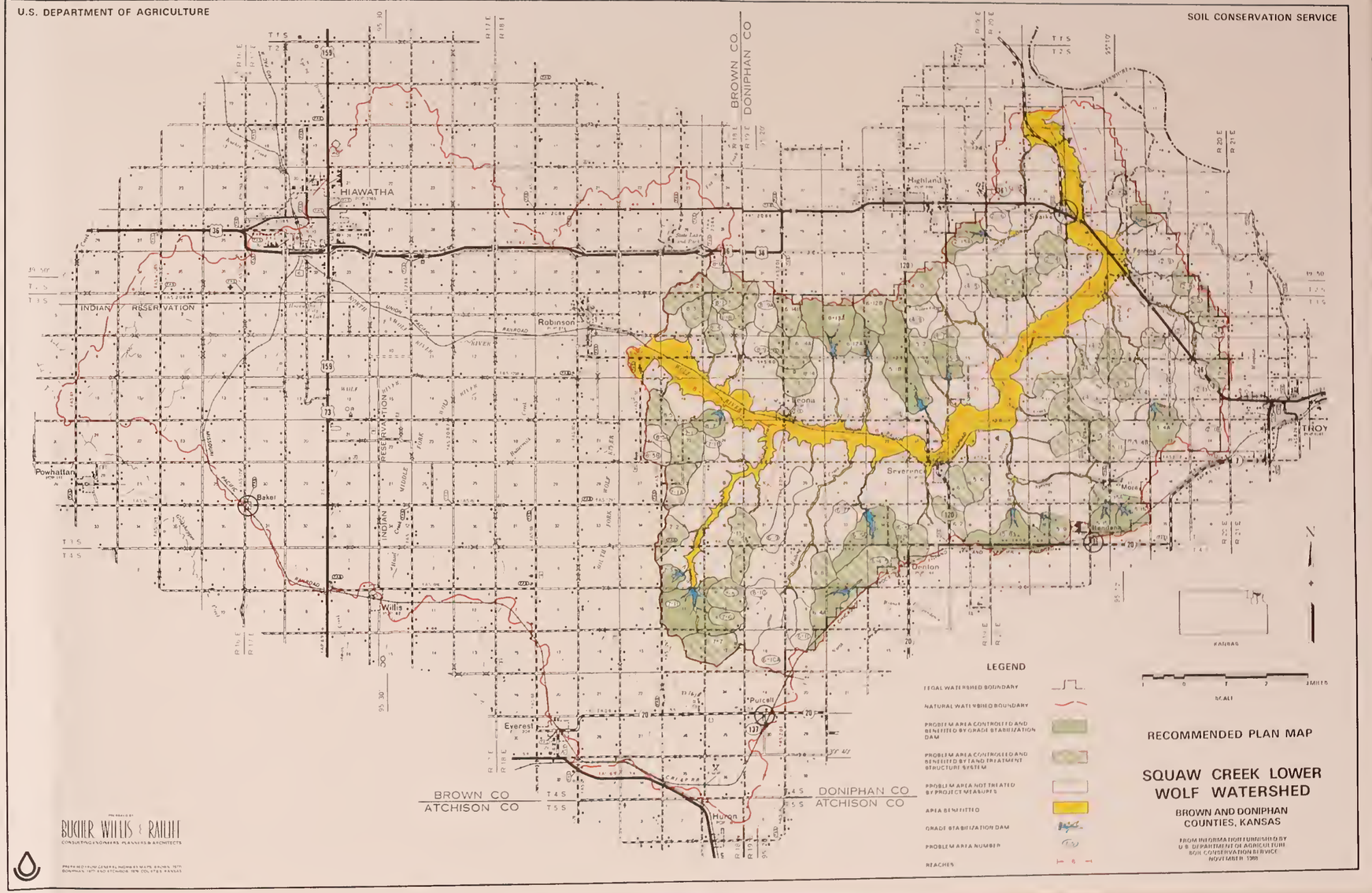
SOIL CONSERVATION SERVICE



RECOMMENDED PLAN MAP

SQUAW CREEK LOWER WOLF WATERSHED

BROWN AND DONIPHAN COUNTIES, KANSAS

FROM INFORMATION FURNISHED BY U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE NOVEMBER 1969

PREPARED BY
BUCHER WILLIS & RATLIFF
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PREPARED FROM CENTRAL HIGHWAY MAPS, BROWN 1977, DONIPHAN 1977 AND ATCHISON 1976 COUNTIES, KANSAS